MONTANA'S NATURAL GAS SUPPLY CRISIS

AN EQC STAFF REPORT
BY
THOMAS W. FRIZZELL

MONTANA STATE LEGISLATURE
ENVIRONMENTAL QUALITY COUNCIL
HELENA, MONTANA
November 1, 1976

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MONTANA'S NATURAL GAS SUPPLY CRISIS

SUMMARY OF MAJOR FINDINGS

The major question concerning Montana's natural gas supply crisis is no longer whether the state can obtain the needed supplies in the face of Canadian decisions to curtail its exports. The question now is how much does Montana wish to pay for what size of supply.

Montana's Natural Gas Supply Crisis, an in-depth study of the latest issues and data prepared by the staff for the Montana Environmental Quality Council, shows that the natural gas required to supply Montana homes, businesses, and industries is available, or can be made available, by decisions within the reach of the Governor and the Legislature of Montana. Careful decisions need to be made among the available and feasible alternatives to choose the combination of costs and benefits that best meets the needs of Montanans. A summary of the natural gas supply crisis in Montana follows, presented as a listing of principal findings and possible solutions based on careful analysis:

The Natural Gas Shortage - Findings

1. Western Montana (serviced by Montana Power Co. and Great Falls Gas Co.) is very dependent on imports of Canadian natural gas, which are being reduced and are likely to be eliminated by 1993.
2. Canadian natural gas policy since 1907 has been that exports can be in surplus of projected demand only. The Canadian Government warned Montana of the danger that gas exports might be cut off as long ago as 1960.

   The Canadian National Energy Board in 1961 said:

   > The market area serviced by Montana Power is becoming increasingly dependent on Canadian gas. Again it

> would appear to the Board to be desirable in the interest of all parties concerned that Montana Power so far as practicable maintain and improve its sources of supply within the United States as a precaution against the contingency of future circumstances in which it would not be in the Canadian public interest to approve applications for additional supplies of gas from Canada.

Montana Power Co. came to rely on imports of Canadian natural gas because it was cheap. It sought to secure a low-cost supply (one of its jobs under law) above absolute security of supply (another of its jobs). Later in the 1960's there were indications to Montana Power which made the Canadian source seen reasonably secure. Montana state government failed to help the company reach a compromise among conflicting mandates, and so failed to prepare for the natural gas supply crisis as it manifests itself in western Montana today.

3. Western Montana could have a natural gas shortage of more than 12 billion cubic feet by 1985 and 45 billion cubic feet by 1990 if supply runs out and demand increases as high as is possible. The probable case, though, is for shortages less severe than the worst case.
4. Eastern Montana (serviced by Montana-Dakota Utilities Co.) is having difficulty in obtaining gas for its region and is faced with a natural gas supply problem. The shortage for eastern Montana is projected to be over 13 billion cubic feet by 1985 and 29 billion cubic feet by 1990.
5. The total natural gas shortage in Montana for 1980 is projected to be 7.92 billion cubic feet, 26.25 billion cubic feet by 1985, and 73.9 billion cubic feet by 1990, at worst.

The Natural Gas Shortage - Alternative Solutions

1. Montana has a number of alternatives available which can prevent the projected "worst case" gas shortages. The alternatives include:
   a. Residential and commercial conservation.
   b. Industrial energy conservation and conversion from gas to other fuels.
   c. Increasing in-state gas production to supply in-state demand.
   d. Low-Btu gasification of coal.
   e. High-Btu gasification of Coal.
   f. Obtaining gas from adjoining states (interstate gas).
   g. Obtaining gas from an Arctic pipeline.

   Some of the alternatives can be implemented readily by changes in state government policy.
2. A residential and commercial conservation program could save 5.7 billion cubic feet by 1980, 14.25 billion cubic feet by 1985, and 18 billion cubic feet by 1990. Such a program might include low-cost loans to residential consumers, tax incentives for residential and commercial consumers and new building standards. Federal technical and financial assistance is available for such state programs; some aspects of a conservation program will be mandatory under terms of a recently passed federal law.
3. Montana industrial consumers already plan to decrease their demand for gas by over 7 billion cubic feet by 1980. In addition industrial gas consumers could further decrease demand through energy conservation and conversion from gas by 4.125 billion cubic feet in 1980, 10.32 billion cubic feet in 1985, and 14.36 billion cubic feet by 1990. This additional conservation and conversion could be assured by state government policies such as tax

incentives and interest assistance. Federal guarantee of bonds for conservation and conversion to renewable energy resources (wood wastes) is available. Conversion to other fuels (namely coal and electricity) might also be included for federal assistance.

4. Proven and undiscovered natural gas reserves, if brought into production, could support Montana's 1974 level of consumption (twice that of present production) for at least 23 years, and possibly for a century. Production in Montana has been held low for a number of reasons, but primarily because of the low price paid for gas produced in Montana. Since 1950, Montana gas producers have been paid the lowest average price (or among the lowest) in the United States. With higher prices Montana could produce substantial quantities of gas in the relatively near future (pre-1985). At $2.00 per thousand cubic feet (approximately, what is to be paid for Canadian gas at the border) Montana would receive an estimated 13.2 billion cubic feet by 1980, 21.78 billion cubic feet by 1985, and 24.78 billion cubic feet by 1990.

5. Low-Btu gasification of coal can produce synthetic gas at a price between $3.00 and $3.50 per million Btus (roughly equivalent to a thousand cubic feet of gas). Low-Btu gasification technology is proven and in use in the United States. At least two Montana industrial consumers have investigated low-Btu gasification and consider it too expensive to use now. This technology is particularly applicable for industrial gas consumers who have a large amount of gas demand which is non-substitutable or where conversion to other fuels is especially expensive. Generally Montana industrial natural gas consumers are not in this situation.

6. High-Btu gasification of coal can produce synthetic gas at a cost between $2.75 and $4.00 per thousand cubic feet, depending on the process and who is making the estimate. High-Btu gasification, if applied in Montana, could provide from 27 billion cubic feet to 75 billion cubic feet of synthetic gas annually depending on the plant's capacity. A five to 10-year lead time is required for planning and construction of such plants.

First generation technology (Lurgi process, for example) can be used commercially (but is not now in use) at a cost of at least $3.00 per thousand cubic feet. Second generation technology promises to produce gas at approximately 15 percent less than the first generation processes, but is not yet in use. Capital cost and end-product prices substantially increased during the development stages of first generation technology; similar increases are expected with newer processes. The largest Montana industrial gas consumer investigated high-Btu gasification and expected the price to be in the $3.50 to $4.00 range. Officers of the firm summarized their present position:

> At this price, we have no immediate plans to produce S.N.G. (synthetic natural gas) ourselves. We prefer to concern ourselves with Natural Gas conservation and to support the drilling of deep wells in Montana to find new gas supplies.

The Montana Trade Commission, working with the Governor's Coal Gasification Task Force, is specifically investigating high-Btu gasification of coal to supply Montana's natural gas needs. It will report to the Governor in November. At this time it favors a demonstration size plant which would produce 27 billion cubic feet of gas annually. This gasification project could be financed from state, private and possibly federal funds. Federal

money is not available now because of problems with legislation in Congress and previous commitments of the Energy Research and Development Administration. Montana Power Co. has expressed an interest in a joint-venture gasification project with the Montana Trade Commission, "if it is technically, economically, legislatively, and otherwise feasible for us (MPC) to do so." Montana-Dakota Utilities Co. was once interested in a gasification project in Wyoming, but it is not known whether they are interested in such a Montana project at this time.

7. Gas from the Arctic could provide Montana with some gas supplies after 1985. This depends on the mode of transportation chosen for the gas and the route chosen for the pipeline if it is the preferred form of transport. Gas from this pipeline is expected to cost \$3.00 to \$3.50 per thousand cubic feet. Montana Power Co. has agreed with Pacific Gas and Electric Co. to purchase a portion of the gas it is to receive from the Arctic. MPC optimistically estimates it might receive 15 billion cubic feet of gas annually if a pipeline is located through or near Montana and the price is reasonable.

Meeting The Natural Gas Shortage

1. Residential and industrial conservation and conversion together can meet the 1980 worst case shortage and almost meet the 1985 worst case shortage. This combination could meet approximately 40 percent of the 1990 worst case shortage.
2. Increasing in-state production for in-state consumption could meet the 1980 worst case shortage at \$2.00 per thousand cubic feet wellhead price. It could make substantial contributions in elimination of the 1985 and 1990 worst case shortages also at the \$2.00 per thousand cubic feet price (1976 constant dollars).

3. A demonstration-size gasification plant (the smallest of the three proposed sizes, producing 27 billion cubic feet annually) could not meet the 1980 worst case projected shortages because it could not be in operation by then. A plant of this size could meet the 1985 shortage. One of these plants could not meet the 1990 worst case shortage, but others could be built in the meantime or other alternatives used to supplement its effect. A commercial-size plant could easily meet the 1990 worst case shortage.
4. Residential and industrial conservation and conversion when combined with in-state production (at $2.00 wellhead prices) would exceed the 1980 and 1985 worst case shortages. By 1990 this combination could eliminate over three-fourths of the worst case shortage. The remaining quarter of the shortage (if it appeared) could be met either by Arctic gas, interstate gas or low-Btu synthetic gas, individually or in combination with one another.
5. If one desired to provide *lowest possible price for the service gas provides to the consumer,* the alternatives rank as follows:
    1. Residential and commercial conservation
       Industrial conservation and conversion
    2. Increased in-state production for in-state use
    3. Interstate gas supply for in-state use
    4. Gasification of coal
       Arctic gas supplies

    A policy wishing to achieve the lowest possible price would implement the demand alternative with in-state production, working to create a slight excess in supply to hold the prices within acceptable levels.

6. If one desired to provide *maximum new employment* over a period of time, the alternatives rank as follows:

   1. High-Btu coal gasification (limited however, to one area)
   2. Increased in-state production (spread over a number of regions of the state)
   3. Conservation and conversion

      Low-Btu gasification (slight increases in employment spread through out the state)
   4. Arctic gas supply

      Interstate gas supply (minimal employment)

   A combination of number 2 and 3, would roughly approximate the new jobs of number 1. A maximum jobs policy would dictate implementing 1,2 and 3 with much of the gas being marketed interstate.

7. If one wanted to achieve *maximum certainty* in prevention of the gas shortage's impacts, the alternatives rank as follows:

   1. Industrial conservation and conversion
   2. In-state production

      residential and commercial conservation
   3. Low-BTU gasification
   4. High-BTU gasification

      interstate gas supply
   5. Arctic gas supply

   A policy which stressed maximum certainty would dictate: a) achieving excess supply before 1980 by rapidly increasing wellhead price for gas (beyond what is outlined in this report) and providing large financial

incentives coupled with mandatory requirements (not recommended in this report) for industrial conservation and conversion. High-Btu coal gasification has lead time problems which limits its pre-1985 effect. Continue to monitor the technical achievement in second generation process and after 1980 move ahead to construct a plant with operation occurring by 1985-1987; thus taking advantage of new developments in the field.

Conclusion: What Needs To Be Done

State government gas policy should concentrate on meeting the projected shortage with alternatives readily available and within its control. A number of alternatives when combined can meet the projected worst case shortages even in 1990. It is very unlikely shortages will occur to the maximum extent; so there is even more flexibility than previously supposed.

MONTANA'S NATURAL GAS SUPPLY CRISIS

BACKGROUND AND ASSUMPTIONS

Introduction

Montana faces a serious natural gas supply crisis. Newspapers tend to emphasize the price side of the crisis with such headlines as: "GAS CRISIS: PAYING MORE FOR LESS," "A GRIM GAS OUTLOOK," and "NATURAL GAS PRICES GOING UP AGAIN." Public concern with high utility bills, possible loss of jobs, and other consequences of the reduction of imported Canadian gas supply has increased steadily since the first public announcements were made in 1972. But largely unexplored have been the possible impacts of decreased gas imports and options available to avoid them. The gas supply problem in the eastern part of Montana has also been unexplored. Gas supplies for all desired uses currently are not available and will not be available if trends continue.

One cause of the natural gas crisis is unique to Montana. No other state is so dependent upon dwindling Canadian gas imports. But Montana's experience is similar to other states in that all are faced with increased demand for gas while supplies and reserves are falling.

The two causes of the crisis--reduced imports and declining domestic production--have unequal impact on the utility service areas in Montana. In 1973, the western two-thirds of the state serviced by Montana Power Co. (MPC) was 87 percent dependent on Canadian natural gas imports. MPC has a supply problem but it does not result from decreased gas production; rather it results from a redefinition and adjustment of Canadian energy policy pertaining to exports. Early in the 1970s, the Canadian government, acting in its best interest, decided to raise export prices and discourage exports.

According to this policy, the volume of exports will be reduced gradually while prices are increased. Montana-Dakota Utilities Co. (MDU), which serves customers in the eastern one-third of Montana, also has a supply problem but it has nothing to do with Canadian energy policy; instead it results from the nation's historical downward trend in gas production and exploration. As a result, MDU says it must curtail service to its industrial customers within the next five years to protect present and future residential and commercial customer's service.

Although the natural gas shortage has two causes, it promises a singular impact on the state. Montana's industrial gas supply will be more expensive and less dependable. Montana citizens already are suffering higher utility bills and workers face possible layoffs from industry's gas shortage shutdowns. Montanans cannot afford to absorb vastly higher fuel costs, job layoffs, and decreased demand for Montana products without severe economic hardship. This human dimension is obscured too often in discussion of energy policy.

The gas crisis is not insurmountable. Montana could respond as other states have with incentives for energy conservation, natural gas production and distribution, and use of alternative energy sources. Montana's large energy resources, particularly coal and gas reserves, suggest many options to deal with shortages. Various estimates indicate Montana has a 23 to 100-year supply of gas reserves at the 1974 rate of consumption. All of this gas may not be tapped, but gas reserves are likely to grow as exploration proceeds. Coal may be transformed into synthetic gas or be burned as a

primary fuel for Montana's industrial boilers in place of gas. Slash and wood wastes may fuel boilers in western Montana. Some industrial gas consumers already have switched from gas to coal and electricity or are considering using coal or wood wastes to replace gas. These are just a few of the options; all should be reviewed and discussed thoroughly and publicly. Pursuing one alternative only might not meet the problem of the state's natural gas shortage, but a number of options, when combined, may prove to be effective.

The Issues

Answers to certain questions are necessary in the analysis of Montana's natural gas shortage. This paper will discuss many issues, including Montana's reliance on Canadian gas imports, how long the situation is likely to continue and whether future and additional imports are possible. Also important is the extent to which the future of Montana's economy is dependent on the availability and cost of gas, the role energy conservation can play in reducing gas demand, and how it can be encouraged in Montana; whether industrial consumers are planning to shift to other fuels, and how much gas can be freed thereby for other uses; and whether synthetic gas can be produced and consumed economically in Montana. Finally, it is important to know how much more in-state gas can be distributed to Montana consumers.

The Analytical Framework

The approach here will be to examine the historical pattern of natural gas demand and supply to put today's situation in perspective. Then the gap

between supply and demand for gas will be identified. Alternative solutions to the gas shortage will be described and analyzed individually, according to the following checklist:

1. The impact of the alternative on the demand for, or supply of, natural gas in Montana.
2. The length of the delay that can be expected before the alternative could have impact.
3. The certainty of the alternative's impact on supply or demand.
4. The cost to the consumer and to the state of pursuing the alternative.
5. The factors enhancing or hindering the pursuit of each alternative.
6. The impacts on supply and demand of a failure of an alternative solution.
7. Actions required to put the alternative into effect (implementation).
8. The side effects of implementing an alternative, positive and negative.
9. The conflicts with other state goals of pursuing an alternative.

Of the many strategies available to implement each of the alternatives, consideration in general is given only to those which provide for:

--Minimum gas price

--No mandatory lifestyle changes (lifestyle changes based on individual voluntary choice were considered)

--Minimum state government involvement

--Maximum beneficial side effects on Montana's economy and environment

--Incentives, not requirements, to encourage action by citizens and corporations

--Maximum certainty in achieving the alternative's potential.

Some implementation strategies discussed here cannot meet all of the foregoing criteria, but to insure that all reasonable alternatives were evaluated and to maintain objectivity, strategies not meeting all the criteria were considered also.

Methodology

To find the answers to the issues surrounding Montana's natural gas supply crisis, it was necessary to contact Montana's major industries, public utilities, the oil and gas industry operating in the Rocky Mountain area, United States and Canadian officials, and individuals in state government. These people deal daily with various aspects of the natural gas problem and are knowledgeable about natural gas and its affects on their particular organization. Large industrial consumers, accounting for over 80 percent of the state's industrial gas demand, were individually interviewed to discover how gas price and supply availability affected their companies. A detailed questionnaire was sent to people and companies exploring and producing oil and gas in Montana.* The results of this questionnaire provided valuable information about the factors inhibiting and/or stimulating gas exploration and production in Montana. These interviews and surveys were supplemented by a review and analysis of the relevant and current technical and policy literature.

Assumptions

This analysis of Montana's natural gas situation is based on the following assumptions:

1. Consumers of industrial gas in Montana will not shut down because it costs money to convert from natural gas to other fuels or because energy conservation requires an investment. Because fuel prices are increasing nationwide, Montana industry would not benefit necessarily by moving to another state and will not do so.

*A summary of the EQC Natural Gas Producers' Questionnaire may be obtained by contacting the EQC.

2. Coal will be available for Montana industrial gas consumers.

3. Population will grow faster than in the past, but not more than 1.5 percent per year.

4. Federal policy on natural gas will undergo only marginal changes during the next five years.

This study is not limited to providing remedies for easing the natural gas shortage. *A major objective of this study is to place Montana's natural gas crisis in perspective, to provide a framework within which various alternatives may be evaluated, and to stimulate reasoned and competent public discussion concerning what could be done to secure natural gas supplies sufficient to meet Montana's short-term and long-term needs.* In this context, the goal is to identify and analyze options which the state could choose not merely to deal with an immediate shortage, but with which the state could achieve economic stability, assure adequate natural gas supplies, and maintain environmental quality.

Introduction

The availability and price of natural gas directly affects all Montanans and the Montana economy. Most Montanans use gas to heat their homes and water (1).* The state's major industries use gas for over 60 percent of their fuel supply--for ore processing, meat packing, and paper and plywood production (2). Gas is distributed to every major populated area by one of three utilities and provides over one-quarter of the energy used in the state (2). Gas from Canada and Wyoming, plus in-state production provides Montana a gas supply at various prices, in differing amounts, and subject to separate regulatory schemes. Canada, supplying over half of the state's gas, has implemented its restrictive policy on exports, leaving Montana with an uncertain energy future. How gas is used and where it comes from are major keys to the state's natural gas supply crisis. A review of historical consumption and supply patterns is required in order to understand the options available to alleviate the gas shortage.

Natural Gas Demand

Montana natural gas consumption has increased, on the average, 4.4 percent annually from 1960 to 1970 (1). Since 1970, however, gas demand has essentially stopped growing. Growth during the 1960s was caused by gas's desirably clean, constant burning temperature as well as its low price relative to other fuels. The recent flattening of demand can be attributed to decreased industrial use, largely a reaction to increasing prices, general conservation practices in the residential and commercial sectors, and mild winter weather. On a per capita basis, Montana gas consumers increased demand 4.1 percent annually in the

* Numbers in parenthesis identify sources listed in the "References" section of this report

1960s. This was faster than total energy demand growth for the same period. In contrast, the 1970s per capita consumption of gas declined 1.23 percent each year while total energy demand continued to rise. These trends are summarized in Table 1.* It is important to note that natural gas use has begun to decline, largely because of a decrease in industrial demand, and conservation practices in the residential and commercial sectors.

Data illustrating gas demand patterns for residential, commercial, and industrial uses are reported in Figure 1. Residential consumers, accounting for 30 percent of total demand, use gas for household purposes, generally for space heating, water heating, and cooling (2). Commercial consumers, accounting for 20 percent of total gas consumption, are the service industries of Montana: stores, offices, government buildings, and college campuses. Industrial consumers are the state's manufacturing, refining, meat packing, ore processing, and wood products industries. Industrials generally have a large demand for natural gas and collectively they consume half of the natural gas delivered in Montana.

Most Montanans use natural gas to heat their homes and water (3). Space and water heating accounts for almost all of the gas used in the residential sector. Other uses, such as air conditioning, cooking, drying clothes, and outdoor lighting, account for slightly more than 1 percent of total residential demand. (See Table 2.) Gas for space heating accounts for the largest component of the peak demand for gas in Montana during any given year. Much more gas is required in winter months, and of course, gas distribution systems must be designed to meet the maximum demand.

Reliance on natural gas by residential consumers is slackening. Many more

*For a discussion of sources and an explanation of how various numbers were derived, see the "Notes to Tables and Figures" section of this report.

TABLE 1

AVERAGE ANNUAL RATES OF GROWTH
OF NATURAL GAS CONSUMPTION IN MONTANA

1960 - 1970	Percent Growth Per Year
Industrial	6.20
Commercial	3.42
Residential	2.42
Total	4.4

1970 - 1975	Percent Growth Per Year
Industrial	-2.10
Commercial	2.71
Residential	0.77
Total	0.252

PER CAPITA RATES OF GROWTH

	Percent Growth Per Year	
1960 - 1970	Natural Gas	Total Energy
Residential-Commercial	2.50	2.15
All Sectors	4.10	3.02

1970 - 1975	Percent Growth Per Year	
Residential-Commercial	0.94	1.65
All Sectors	-1.23	1.52

figure 1

Montana Natural Gas Consumption By Sector
(1950 - 1975)

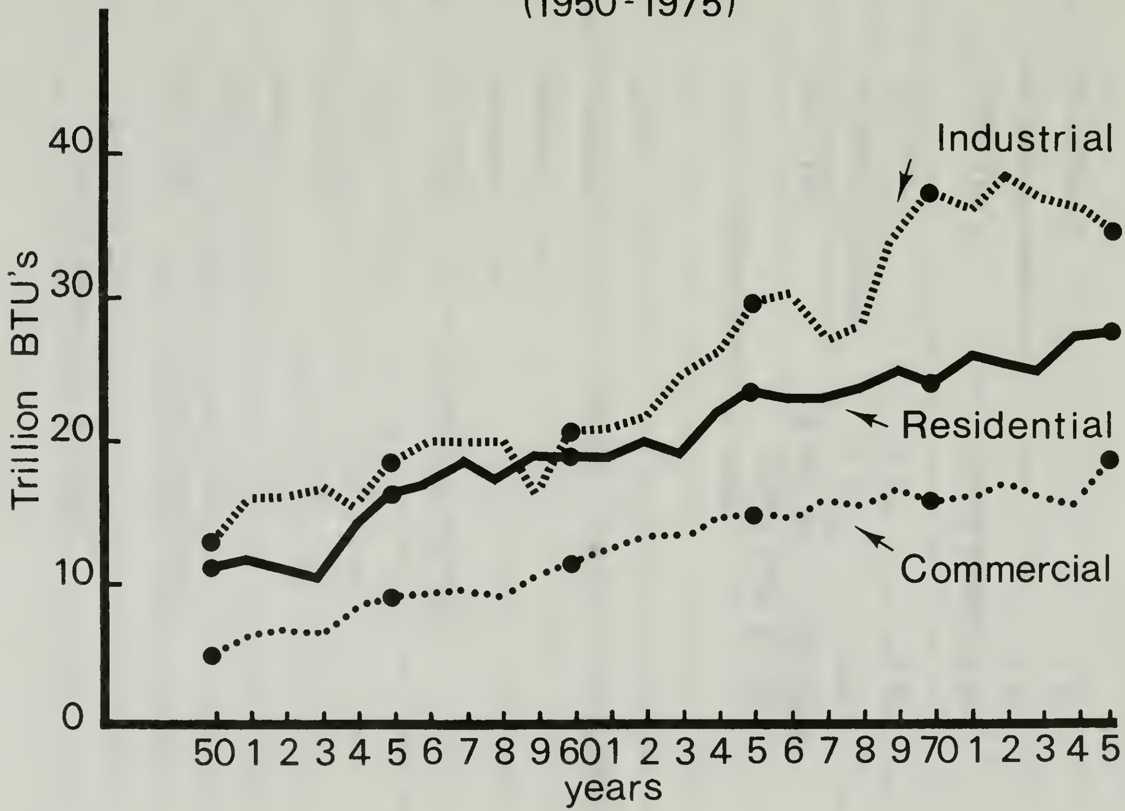


TABLE 2

ESTIMATED RESIDENTIAL END USE OF
NATURAL GAS IN MONTANA

Appliances	U.S. Average Annual Use Per Household (mcf)	Percent of Montana Households Using Appliances	Estimated Montana Consumption (bcf)	Percent of Natural Gas Used by Montana Residents for Various Appliances	
				MEAC	EQC
Gas Space Heater	119	69.5%	17.97	78.1%	77.36%
Gas Water Heater	32	61.9%	4.30	18.7%	21.03%
Gas Range	10	25.1%	.55	2.4%	1.3%
Gas Clothes Dryer	7	3.4%	.05	0.2%	0.2%
Gas Air Conditioner	28	0.3%	.02	0.1%	0.13%
Gas Light	18	2.8%	.11	0.5%	0.0615%
Total			23.00	100.0%	100.0%

all-electric homes are being built than in the past. Although gas service is not being denied outright and gas generally is still cheaper than electricity or oil for home use in Montana, many people choose not to use gas because of the uncertainty of future supply and price (3). The initial decision not to use gas, when combined with the replacement of the old gas appliances with electric ones and general conservation practices, accounted for the small average annual increase in residential gas demand (0.77 percent per year) from 1970 to 1975 (1). The end use for gas purchased by the commercial sector is largely space heating, with some water heating and cooking. Commerical gas demand grew faster than residential consumption but less than that for the industrial sector between 1960 and 1970 (1). In recent years, however, commercial gas demand has recorded the largest increase of the three sectors.

The industrial sector, accounting for the fastest growth in gas demand in the 1960s (6.2 percent average annual growth from 1960 to 1970), uses gas for most of its fuel supply, primarily as a boiler fuel (1)(4)(5)(8). In some cases, industrial consumers using gas cannot substitute other fuels easily. Here, the general problem is that burning a fuel other than natural gas would contaminate products (6)(7). Even so, some fuels can be substituted for gas and its efficiency of use can be improved in most industrial facilities. Trends in industrial demand have virtually reversed in the 1970s. From 1970 to 1975, industrial demand fell an average of 2.1 percent annually, while demand in the residential and commercial sectors continued to rise (1).

Fuel substitution and gas conservation through more efficient use accounted for the decline in gas consumed by industrial customers since 1970 (6). Price was the major spur to industrial conservation and substitutions.

In addition, the Montana Public Service Commission (PSC) ordered industrial consumers to prepare gas conservation plans in 1975. A review of these plans showed that many industrial consumers had taken steps to decrease gas consumption significantly (6). Nearly all of them met the Commission's order to reduce gas consumption per unit of output approximately 10 percent by 1976 (6)(7). This occurred without PSC enforcement.

Industries obtain their natural gas on the basis of contracts, the terms of which stipulate that during periods of shortage gas may be diverted from industrial to other uses. In cases of severe shortage, the Federal Power Commission (FPC) has established schedules ranking the order in which industrial uses would be curtailed. Under this system residential and commercial customers are affected after the industrials. The FPC's nine priorities, eight of which include industrial customers, fall into three general classes (8).

Under the FPC curtailment schedule, the first uses to be eliminated are those for which alternate fuel capabilities exist, regardless of whether such facilities are currently installed. The last industrial uses to be eliminated are those required for plant protection (gas used in some way to prevent damage to the plant), as feedstock (gas used as a raw material in products), or as process gas (uses requiring gas's even burning, constant temperature characteristics). Natural gas used for plant protection, feedstock, and process purposes has no fuel substitute except propane. In between these is a catchal category defining uses that are unrelated to plant protection, feedstock, or process needs for which substitutes are not available.

Within these categories, Montana industrial consumers can substitute other fuels for approximately 30 billion cubic feet or 86 percent of the industrial

gas consumed each year (4)(5)(8)(9). This is shown in Table 3 for the MPC service area and Table 4 for the MDU service area. These tables identify the large industrial consumers and their gas requirements according to whether the gas currently consumed is substitutable. These industrial consumers account for over 95 percent of the MPC and MDU industrial demand (4)(5)(9). *The conclusion is that the vast majority of natural gas consumed by industrials can be replaced by other fuels.* The remaining demand, about 14 percent of the total industrial use, is extremely valuable to industrial consumers and must be considerable irreplaceable. Without this high-priority gas, industrials might have to shut down (7).

Natural Gas Consumption and Price

Demand for natural gas is very much affected by price. The relationship between price and amount consumed is called price elasticity of demand. It depends on: 1) the number of effective substitutes, 2) the relative prices of those substitutes, and 3) the ease of switching from one substitute to another.

Substitutes for natural gas in space heating, for example, could be fuel oil, electricity, coal, wood, and solar power. Of these substitutes, natural gas is still the cheapest way to heat a house. Gas is also cheaper than coal or electricity as an industrial boiler fuel. An inelastic demand would be one where demand would not react significantly to price increases (less than 10 percent decrease in demand, for example, in response to 10 percent increase in price). The residential sector has a relatively inelastic demand for natural gas because it is very expensive to convert from gas to other fuels.* In

*Residential price elasticity for natural gas is approximately -.22 for the short term and -.44 for the long term. Commercial price elasticity for gas, is approximately -.44 for the short term and -.88 for the long term (10).

TABLE 3

AVAILABILITY OF NATURAL GAS SUBSTITUTES FOR MAJOR INDUSTRIALS
IN THE MONTANA POWER COMPANY SERVICE AREA IN 1974.
(million cubic feet @ 14.73 psia, 60° F.)

Customer	Location	No Substitutes	Unknown	Substitutes	Total Gas Used
Anaconda Co.	Anaconda	93		10,629	10,722
Anaconda Co.	Butte	686		427	1,113
Anaconda Co.	Great Falls	552		1,066	1,618
Anaconda Aluminum Co.	Columbia Falls	96		425	521
ASARCO	East Helena	37		469	506
Big West Oil Co.	Kevin	2	18	251	271
Borden Chemical	Missoula		81		81
Burlington-Northern	Havre	31	1	36	68
Burlington-Northern	Livingston	13		260	273
C & C Plywood Corp.	Kalispell			243	243
Hoerner-Waldorf	Missoula	16		4,536	4,552
Ideal Cement	Trident	3		2,121	2,124
Kaiser Cement	Montana City	10		1,709	1,719
Louisiana-Pacific	Deer Lodge		71		71
Louisiana-Pacific (particle board)	Missoula			202	202
Louisiana-Pacific (plywood)	Missoula	3		250	253
Mountain Phosphate	Garrison			288	288
Pfiser	Dillon	2	9	232	243
Plum Creek Lumber (particle board)	Columbia Falls			111	111
Plum Creek Lumber (plywood)	Columbia Falls			223	223
Stauffer Chemical	Butte	33	40	635	708
United Sierra (Cyprus Mines)	Three Forks	2		261	263
Westco Refining	Cut Bank	50	20	309	379
TOTAL		1,629	240	24,683	26,552

TABLE 4

AVAILABILITY OF NATURAL GAS SUBSTITUTES FOR MAJOR INDUSTRIALS
IN THE MONTANA-DAKOTA UTILITIES SERVICE AREA IN 1975
(million cubic feet @ 14.73 psia at 60° F.)

Customer	Location	No Substitutes	Unknown	Substitutes	Total Gas Used
Continental Oil	Billings	185		1,628	1,813
Exxon	Billings	250		10	260
Farmers Union Central Exchange	Laurel	77		1,003	1,080
Gary Operating	Bell Creek		136		136
Great Western Sugar	Billings	10	395	1,388	1,793
Holly Sugar	Sidney	3	511	914	1,428
Lovell Clay	Billings	80			80
Midland Empire Packing	Billings	40		64	104
Pierce Packing	Billings	156	330		486
Shell Oil (Little Beaver)	Baker	1	96		97
Shell Oil (Pine Unit)	Baker	3	436		439
Shell Oil (Meter No. 117987)	Baker	2		166	168
Tesoro Petroleum	Wolf Point	13		35	48
TOTAL		820	1,904	5,208	7,932

comparison, industrial consumers have an elastic demand. Given price changes, they can replace large amounts of gas with other fuels. A few industrial gas consumers in Montana have or are in the process of switching to other fuels. This is a result of today's prices as well as the expectation of even higher prices and limited availability in the future. The companies that are switching believe it is better to switch now, rather than face possible shutdowns because of lack of fuel or face high long-term fuel costs (7). In general, only those companies with industrial processes and equipment highly adaptable to coal or other fuels have switched from gas. As the price of gas increases, though, conservation practices and changes to other fuels are likely to become more prevalent in all sectors.

In Montana, gas is sold on two basis pricing system. The first system is the so-called block rate structure or promotional pricing. It is used for residential and small commercial customers who pay less on the average for each unit of gas as they burn more of it. Under the MPC block rate structure (not unlike MDU's) consumers pay a fixed charge for an initial 1,000 cubic feet (lmcf) of gas (11)(12). Then for the next block of 99 mcf consumers pay a lower price per cubic foot (11). Most residential consumption falls into this block. For the next 100 mcf the charge per cubic foot is even less. Such a pricing structure may promote gas consumption because a consumer receives a discount, per unit purchased, proportional to the amount consumed. (See Table 5 for this data.) One criticism of the pricing system is that it induces residential and commercial consumers to buy more gas, because it costs less per unit, and encourages industrial consumption of a scarce resource for which substitutes are available, hence

TABLE 5

COMPARISON OF NATURAL GAS BLOCK RATES
FOR MONTANA POWER COMPANY AND MONTANA-DAKOTA UTILITIES, 1976

Montana Power Company

Residential Service		Base Rate
First	1 mcf or less per month	$ 3.6710
Next	99 mcf per month	@ $ 1.5820
Next	200 mcf per month	@ $ 1.3430
Next	700 mcf per month	@ $ 1.2010
Next	4000 mcf per month	@ $ 1.1530

Commercial Service		Base Rate
First	1 mcf or less per month	$ 3.8071
Next	99 mcf per month	@ $ 1.7181
Next	200 mcf per month	@ $ 1.4791
Next	700 mcf per month	@ $ 1.3371
Next	4000 mcf per month	@ $ 1.2891

Montana-Dakota Utilities

General Gas Service (includes residential and commercial service)		Base Rate
First	10 mcf per month	$ .9665 per mcf
Next	5 mcf per month	$ .8065 per mcf
Next	15 mcf per month	$ .9665 per mcf
Next	70 mcf per month	$ .9165 per mcf
Next	100 mcf per month	$ .7765 per mcf
Over	200 mcf per month	$ .6365 per mcf

encouraging the waste of resources.

The second price system is based on the interruptible contract in which industrial consumers contract with utilities for certain amounts of gas at a bargain price, provided that during periods of short supply (peak demand periods, generally in severe winter days) the consumer may have gas service interrupted. The chief benefit of this pricing system is said to be that the interruptible demand (or load) helps pay for the pipeline and distribution systems (fixed costs) when the peak load is not being asked of it.

Among the three sectors, residential consumers pay the highest unit price for gas; commercial and industrial consumers pay respectively less (1)(2). This price difference is said to be justified because fixed production costs (distribution lines, metering, billing) are respectively higher for residental, commercial and industrial customers. Also it is said that the industrial consumers should receive a bargain price for their sufferance of interruptibility of supply during period of peak demand. In recent years, prices for natural gas paid by industrial consumers have moved toward parity with the prices paid by other sectors, although the prices each pay are not equal. Actual prices paid for natural gas in Montana by the three major sectors are shown in Figure 2; real prices of gas (price paid adjusted for inflation) are shown in Figure 3. Real price data illustrate that Montanans must spend more of their income for gas than ever before.

Natural Gas Supply: Two Regions, Two Causes, One Impact

Montana receives natural gas from three sources: in-state production, Canada, and Wyoming. For each of these supply sources there are different regulatory schemes and prices. From 1950 to 1975, Montana received over half

figure 2

Montana Natural Gas Prices
(actual prices)
1950-1975

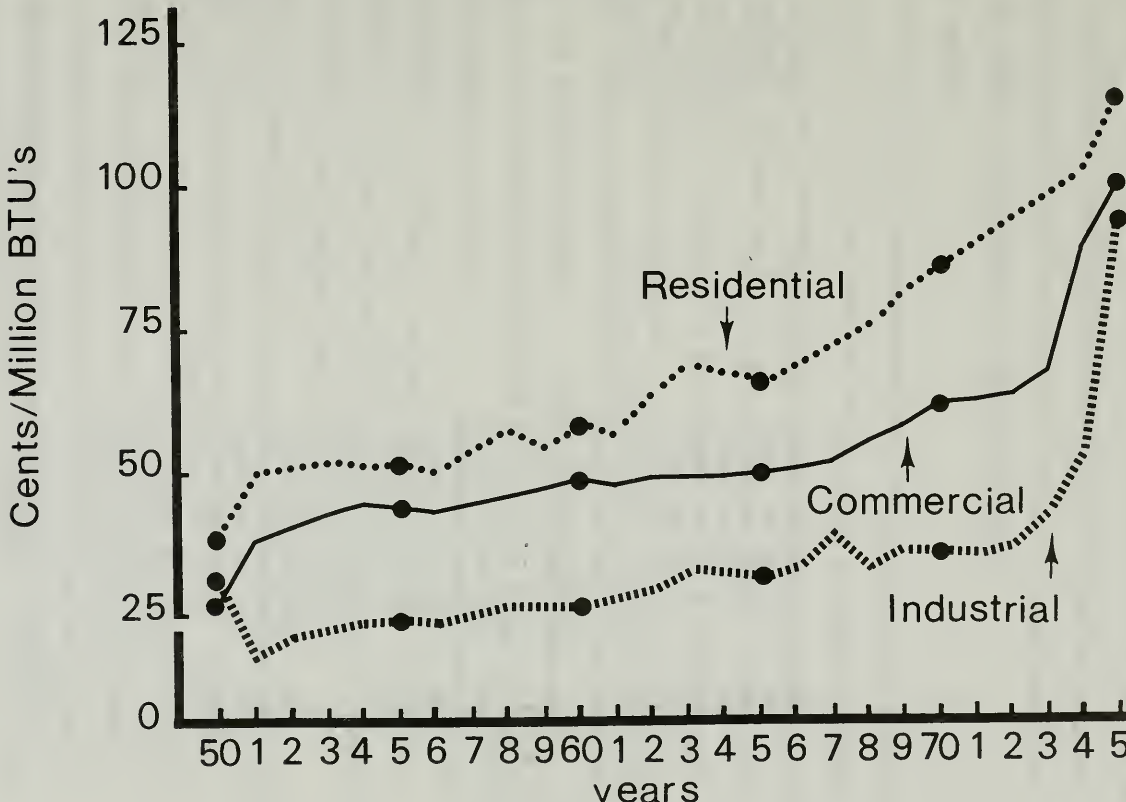
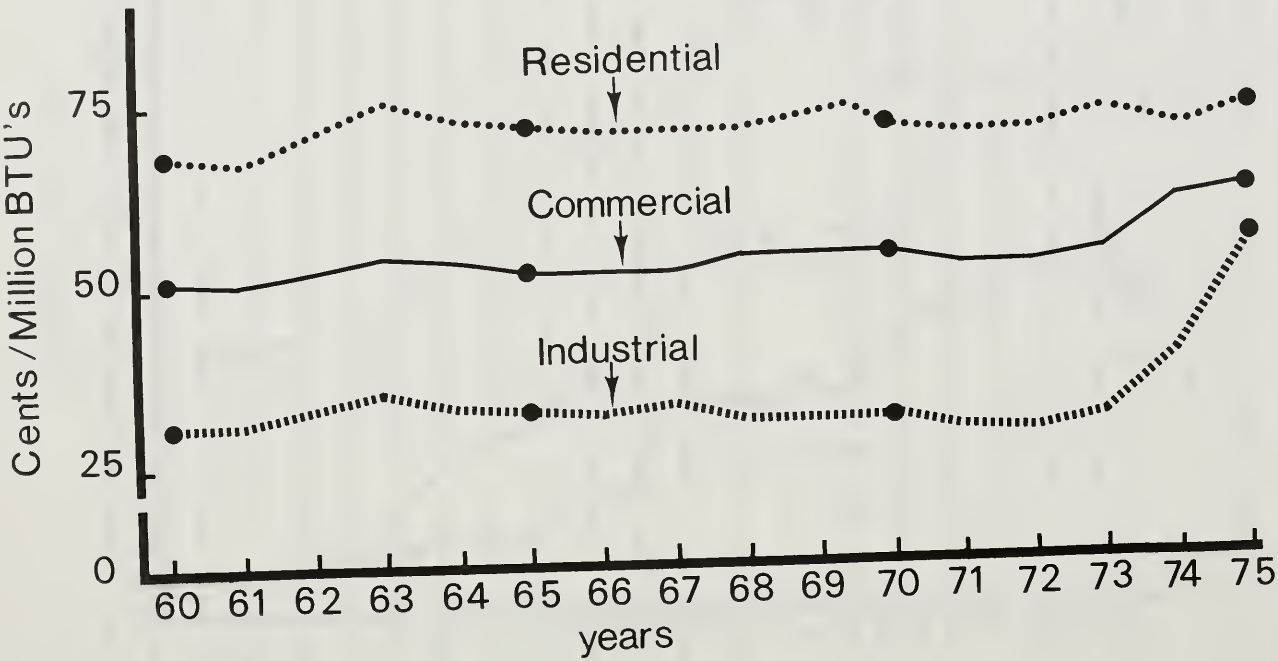


figure 3

Montana Natural Gas Prices
(deflated by Consumer Price Index for all goods: 1967=100)



of its gas supply through imports, mostly from Canada, as shown in Figure 4. Within the western utility service area, these imports and their attendant pricing schemes have had a much larger impact than on the state in general. The MPC service area last year received more than 80 percent of its gas from Canada (9)(13). These prices, set by Canadian regulatory laws, have risen rapidly, a trend likely to continue (14). This situation has a profound effect on the MPC service area, but little or no effect on the remaining one-third of the state. Yet the MDU service area is facing a similar problem. There, prices, regulated by the Federal Power Commission, used to be low (which discouraged production) but now are much higher (to encourage production). This recent change has had a significant effect on MDU consumers, but not as much on MPC's consumers because they were already paying high prices for gas, It is this interrelationship between source of supply and the regulatory climate for each source that is the central focus of this section.

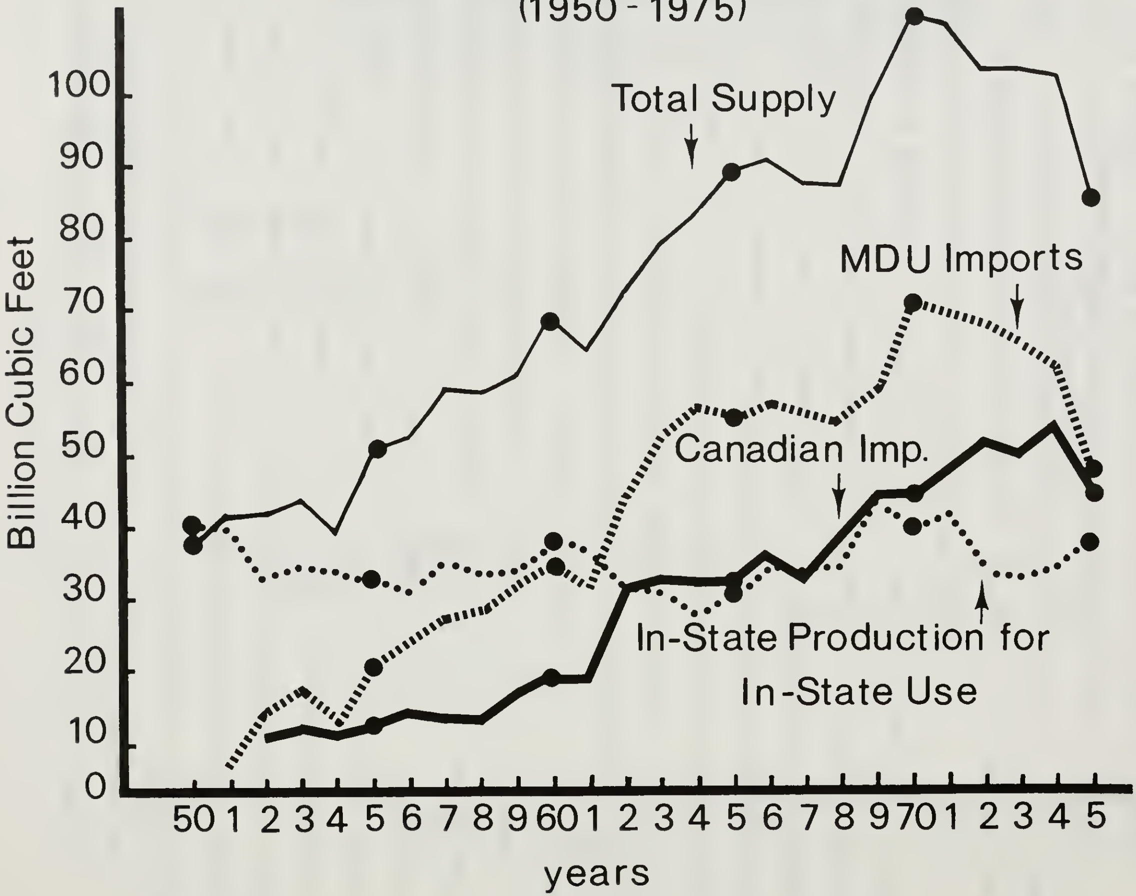
In-State Production

MDU and MPC both buy gas produced in Montana for in-state consumption, accounting for approximately 38 percent of supply between 1960 and 1975 (13). The contribution to gas supply from in-state production historically has been relatively low. Gas produced in Montana and used in the state is purchased under two sets of prices, one offered by MPC and the other by MDU. MPC and MDU do not buy gas in the same areas, hence do not compete with one another. In addition to MPC and MDU, out-of-state utilities bid for Montana gas, within wellhead price controls set by the FPC.

It would appear that for any given source of gas in Montana, there would be many buyers. This is not the case, however, since each utility has pipeline

figure 4

Sources of Montana Natural Gas Supply
(1950 - 1975)



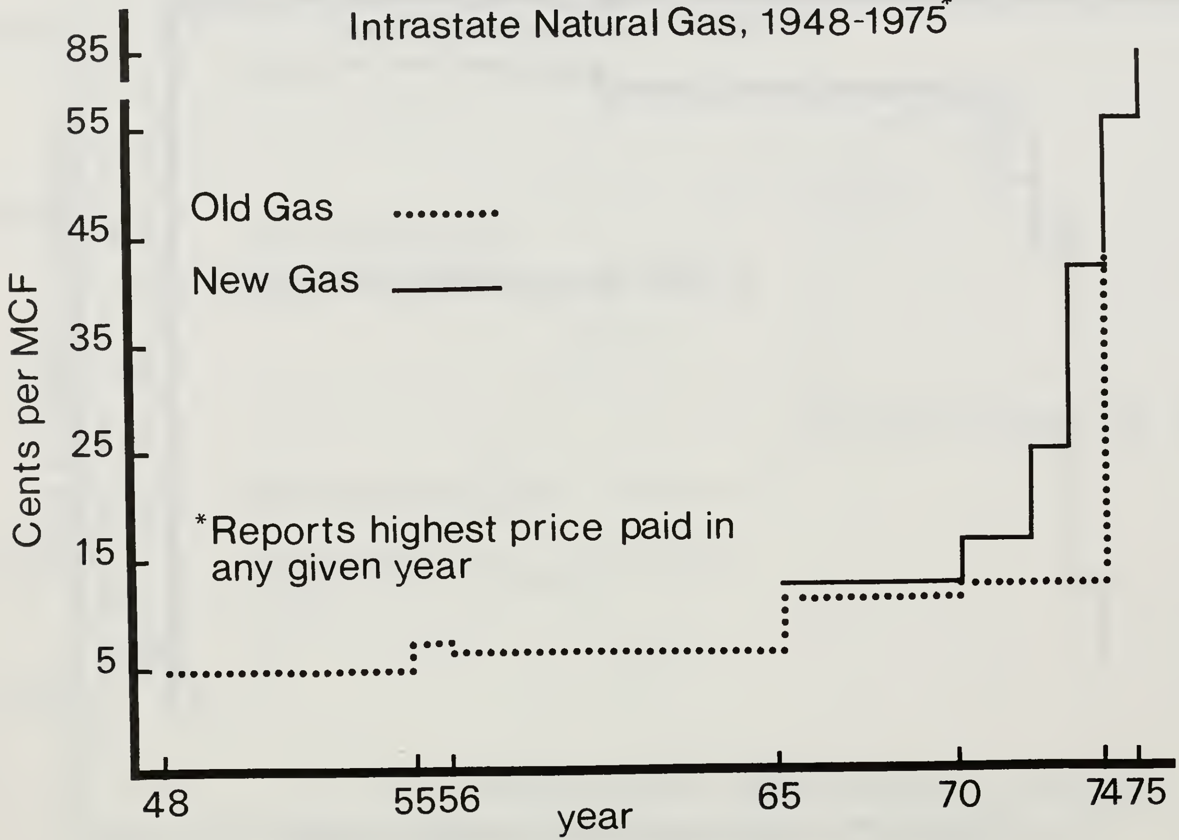
systems (gathering and distribution lines) in limited areas only. The only areas with competition are in the north central part of the state where MPC's pipelines press eastward (15). This lack of competition has lead to a depressed gas market, keeping intrastate prices low and inhibiting Montana gas production.

Montana Power Company, faced with a cutback of its largest source of supply, has increased dramatically attempts to obtain in-state production for Montana distribution. The effort has taken two forms: offering higher prices for gas and increasing MPC's own exploration and development activities. In 1974 MPC renegotiated old contracts in which producers were paid 10 cents per thousand cubic feet for gas and increased the price to 40 cents (16). The agreement included a provision allowing MPC to receive first chance (first call) in bidding for the gas discovered on some 7.8 million acres. Also, MPC raised the price it paid for new gas to as high as 85 cents per thousand cubic feet (16). Figures 5 and 6 list the prices paid by MPC for in-state production and for Canadian gas imports. MPC has increased its gas exploration and development budget for Montana more than six-fold in the last decade, tripling it within the last three years (see Figure 7). With these expenditures MPC believes it can increase greatly the production of Montana gas. Although the full effect of the new effort will not be seen for a few years, initial indications are favorable.

It should be noted that much gas produced in Montana is shipped to other states. In-state gas production has supplied gas to South Dakota, North Dakota and just recently the midwest via a Northern Natural Gas Company pipeline. Soon, more of Montana's gas will be shipped to the midwest by Colorado Interstate Pipeline Company. Although this gas is produced in Montana, its journey to other

figure 5

Prices Paid by MPC for Old and New Intrastate Natural Gas, 1948-1975*



*Reports highest price paid in any given year

figure 6

Prices Paid by Montana Power Company for Canadian Gas, 1952-1976*

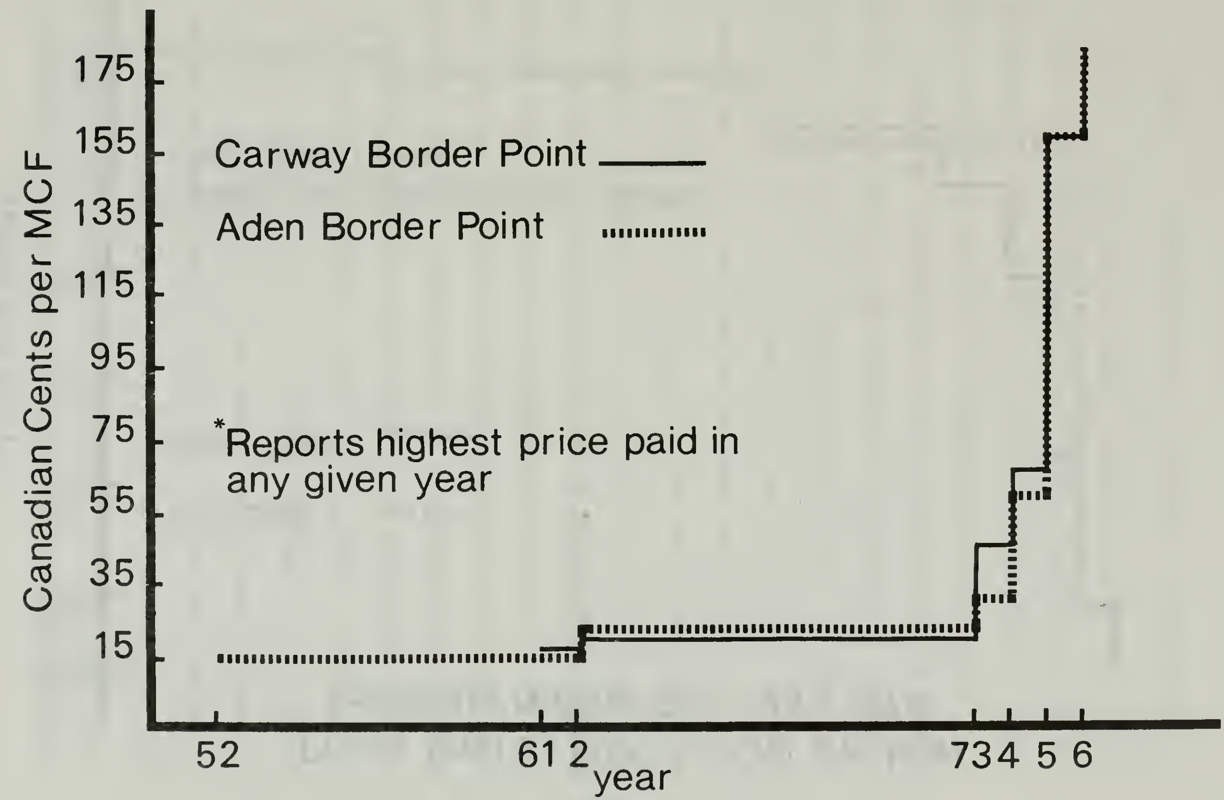
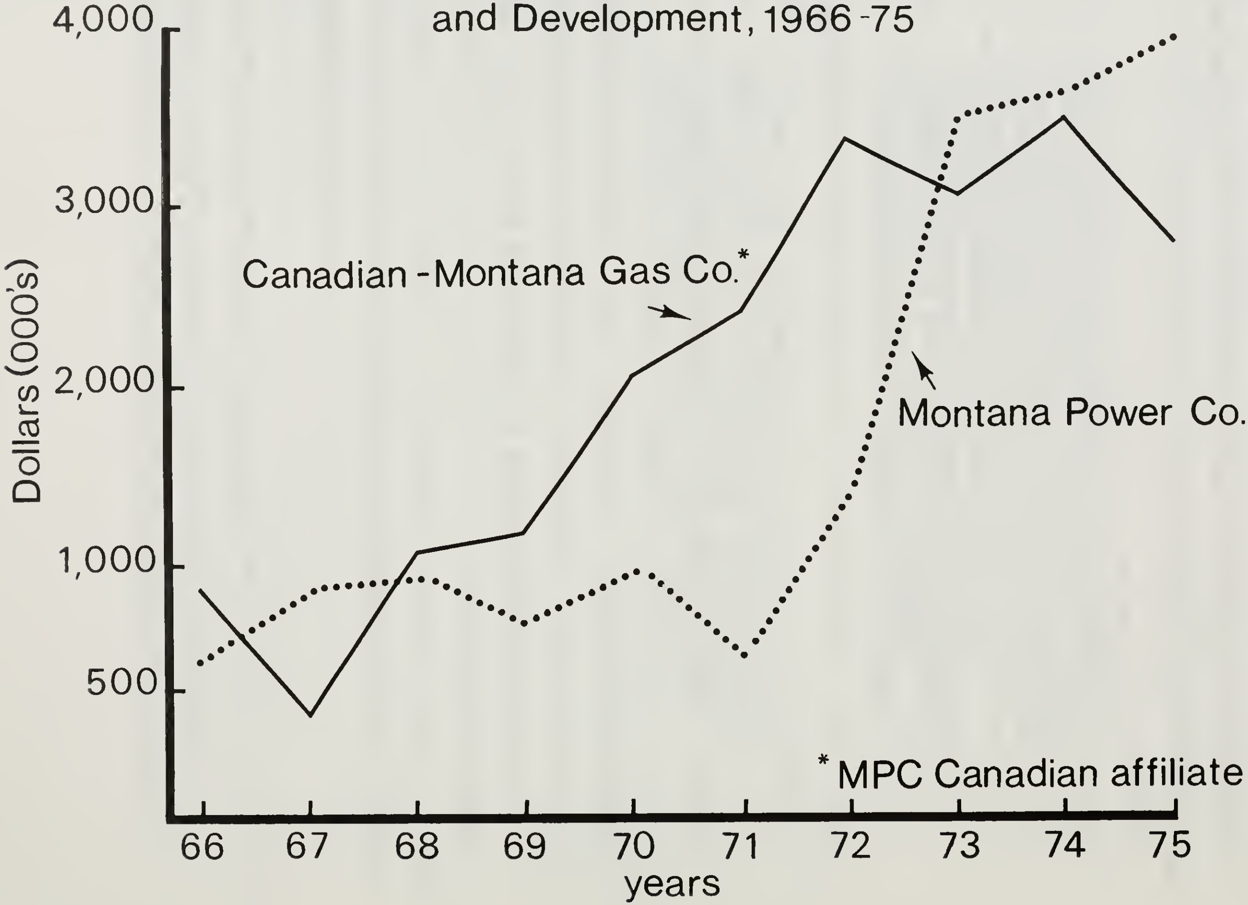


figure 7

MPC Expenditures for Natural Gas Exploration and Development, 1966-75



states cannot be interrupted by state government policy because of constitutional restrictions. Even though natural gas production generally has increased in recent years, Montana still imports more gas than it produces (13).

Interstate Gas Supply

Wyoming provides a large part of Montana's natural gas supply, which is delivered to the MDU service area. MDU services five states--Montana, Wyoming, the Dakotas, and a portion of Minnesota--with gas and draws upon each for supplies (4). MDU has not been able to obtain new supplies of gas in what it believes to be sufficient quantity. As result, MDU filed an application for curtailment of industrial service with the FPC. In the application MDU said (4):

> Beginning in the supply year 1976-1977, MDU will be required to impose annual gas supply curtailment on its large industrial (Priority 4 and above)* customers. In the first Supply Year (1976-1977) curtailment will be at a level of approximately 21.4 percent of Priority 4 Base Period Requirements.

In the same letter, MDU explained:

> Gas supply curtailments are imposed only on an annual basis, and their primary purpose is to allow the unimpaired service to existing high priority customers as well as the contained attachment of new high priority (residential-commercial) customers. MDU's large existing storage operations give it the flexibility necessary to impose only annual gas supply curtailments. The relatively large industrial use of gas by relatively few industrial customers who can convert to alternative fuels also makes the transition far less disruptive than customary with other pipelines. (emphasis added)

MDU's actions are what would have to be done in other service areas, if gas supplies were to grow expecially short. Residential consumers, the highest priority gas customers, would be provided service at the expense of consumers lower in priority.

*MDU's reference to "Priority 4 and above customers" corresponds to the list of companies contained in Table 4 of this report.

MDU is planning to obtain 30 billion cubic feet of gas reserves per year to supplement its existing reserves and underground storage capacity (4). The FPC's proposed higher interstate prices, in MDU's opinion, will help the company achieve its goal of additional reserves. If the curtailment plan is allowed, and with the new reserve additions, MDU believes it can service its present and future residential and commercial customers well into the 1990s (4).

Natural Gas from Canada

Canadian gas has been imported to Montana since 1952, initially under a permit by the Province of Alberta, specifically for gas service to the Anaconda Copper Company during the Korean war (18). Since that time, Montana's reliance on Canadian gas has grown very rapidly. Imported Canadian gas as a percentage of Montana's total gas supply peaked in 1973 when it comprised more than 64 percent of the supply (87 percent of MPC's supply) (9)(13). The largest amount of gas imported in a year was 50 billion cubic feet in 1973 (13). Soon thereafter Canadian policy changed; imports became more costly and less available.

To import gas from Alberta three permits are required; one to get the gas out of Alberta (granted by the Albertan Energy Resources Conservation Board), one to get gas out of Canada (from the National Energy Board), and one to get it into the United States (from the Federal Power Commission)* (19). Each of these agencies have different price regulations and can restrict the amount of gas transported.

Alberta's gas export regulations, established in the Gas Resources Preservation Act of 1956, aims toward "the preservation and conservation of the oil and

*FPC approval of gas imports from Canada has not been a problem for Montana.

gas resources of the Province and to provide their effective utilization having regard to the present and the future needs of persons within the Province" (emphasis added) (19). Not even neighboring provinces in Canada can export gas from Alberta unless there are exportable surpluses. Exportable surpluses are based on two criteria: the present and future need of persons within the province and the established reserves and the trends in growth and discovery of Albertan reserves of gas.

Montana's major difficulty with gas imports hinges on policies established by Canada's National Energy Board (NEB). The NEB allows for a 25-year period of expected Canadian gas demand, taking into account trends in discovery and production of gas reserves before allowing exports, a system of accounting the NEB recently discarded (20)(21). A collateral policy has been to raise gas prices to match those of substitute fuels (mainly coal and oil). The NEB's authorizing legislation allows exports of unneeded gas only. Before a license to export gas can be issued, the NEB by statute must be satisfied that (22):

a. the quantity of gas or power to be exported does not exceed the surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada having regard, in the case of an application to export gas, to the trends in the discovery of gas in Canada; and

b. the price to be charged by an applicant for gas or power exported by him is just and reasonable in relation to the public interest

The tests established by the National Energy Board for determining what price is "just and reasonable" for Canadian gas exports are (19):

1) the export price must recover its appropriate share of the cost incurred;

2) the export price should, under normal circumstances, not be less than the price to Canadians for similar deliveries in the same area; and

3) the export price of gas should not result in prices in the United States market area materially less than the least cost alternative for energy from indigenous sources.

The recent Canadian decision to curtail and eventually eliminate natural gas exports to Montana should not have come as a surprise. *As early as 1960, the National Energy Board warned Montana that Canadian gas exports were an unstable source of supply* (23). The NEB suggested that Montana improve its source of supply within the United States to protect itself against the possibility of future Canadian gas export restrictions. The NEB stated in 1961, on public record, that (23):

> As it did in its March 1960 and June 1960 Reports, the Board notes the extent to which the market area served by Montana Power [Co.] is becoming increasingly dependent on Canadian gas. Again it would appear to the Board to be desirable in the interest of all parties so far as practicable maintain and improve its source of supply within the United States as a precaution against the contingency of future circumstances in which it would not be in the Canadian public interest to approve applications for additional supplies of gas from Canada. (emphasis added)

Later it stated:

> The Board wishes to emphasize once again, in the light of the substantial and growing dependency of the Montana gas market upon Canadian gas, that it cannot undertake to issue a license in the future to meet any incremental demand, or any deficiency in the supply available to meet existing demand, in the said Montana gas market to be supplied by the Applicant. The Board is required to consider each application for an export license in the circumstances existing at the time and, of course, it cannot commit the Governor in Council to validate any license which the Board might issue in the future. (emphasis added)

Since this statement, MPC received further permits from the National Energy Board. This action, combined with discussions with Canadian officials, led MPC to believe its Canadian gas source was relatively secure. The Canadian statutory and regulatory policies, however, remained as hard evidence of what

the future could bring.

On June 30, 1971, the NEB declared that Canada had no current surplus of natural gas. Instead, it reported a deficiency of over a trillion cubic feet, before even looking at various export requests. In announcing the deficit, the Board stated (19):

> However it should be clearly understood that this calculation is exclusive of all new discoveries and all further appreciation of existing reserves in the forthcoming 25 years. The Board fully realized that further discoveries are being made and that there will be appreciation of existing reserves considerably in excess of what may be necessary to cover the indicated deficiency of 1.1 TCF and therefore the Board remains confident that the requirements for gas for use in Canada can and will be met.

This action initiated the NEB policy of restricting Canadian exports. It should be noted, however, that many Canadians, particularly in the Albertan government, were unhappy with the NEB decision because they believed the NEB had overestimated Canadian domestic demand and underestimated the potential of new discoveries, particularly in the Arctic. Some Canadian observers believe, based on the NEB's decision to review export permits annually, the NEB has not established a definitive export policy. However, the opposite appears to be true. The present natural gas policy of restricting imports finds its roots in Canadian statutes dating back to 1907, reestablished in the 1950s, noted in the decisions of the 1960s, and applied in the 1970s (19) (20)(22)(23). *Montana had ample warning.*

The future of Canadian imports is uncertain. The Albertan government desires to ship gas to Montana but at a high price. The NEB agrees with the high price but doesn't believe there is gas in reserve sufficient to support exports. This estimate of future demand and reserves can change

easily with shifting Canadian policies, international crises, and successes in gas exploration. The immediate future of Canadian gas imports will be better established when the NEB issues another supply-demand estimate for the ongoing McKenzie Valley hearings. The estimate should be ready by the end of 1976 with the completion of current hearings (21).

MONTANA'S NATURAL GAS SHORTAGE

Introduction

The extent of Montana's gas shortage depends on future gas demand, Canadian gas imports, interstate gas supply and in-state gas production. As stated earlier, supply problems of MPC and MDU are different in kind and degree, so in the definition of the state's shortage they will be treated separately.

In estimating Montana's natural gas shortage, the EQC staff used a "worst case" approach. As applied in this section of the report, to reach a "worst case" prediction, *demand will be overestimated* to account for the maximum demand that must be met; *supply will be underestimated* so the minimum amount of natural gas available will be shown. The estimates of Montana's natural gas shortage presented here also are based on the assumption that no policy changes in the state will affect supply and demand trends. This approach establishes a framework within which various technological and policy alternatives may be analyzed to assess the maximum contribution they could be expected to make. *The results presented here have a high degree of certainty since there is little chance that the shortages will be as large as projected and all the alternatives examined are designed to meet this exaggerated shortage.*

Demand in Western Montana*

There will be little, if any, increase in demand for natural gas in western Montana between 1977 and 1990 (3). This low-growth situation is the

*Great Falls Gas Company and Montana Power Company Service Areas.

result of the dramatic increase in price of gas (1)(2). Consumers have been encouraged to use other fuels and to use gas more efficiently through energy conservation. Other factors restricting growth in residential and commercial demand will be changes in the types of dwellings people choose (from single family houses to apartments and mobile housing) and the uncertainty of gas supply.

EQC demand projections allow for 1.5 percent average annual growth in natural gas demand in the residential and commercial sectors. This assumes people in the future will use gas in the same proportion as they do now and population will increase on the average of 1.5 percent per year. For comparison, natural gas demand in the residential sector increased on the average of 2.42 percent annually from 1960 to 1970 and grew an average of 0.77 percent per year from 1970 to 1975. The assumption of 1.5 percent growth is considered to be higher than will occur.

Many industrial consumers have already taken steps to decrease their gas demand. Industrial consumers in western Montana (accounting for a total of 82 percent of the industrial gas demand) were interviewed to find what steps they were taking to convert from gas to other fuels and to conserve natural gas (6)(7)(9). Some new growth in gas demand was discovered because a few industrial consumers are increasing production even though they are decreasing the amount of gas used to produce each unit of product (6)(7). The decreases in demand resulting from conservation and conversion to other fuels were balanced against planned increases in demand to yield an estimate of future industrial demand. In the MPC service area of western Montana, it was found that there would be a net decrease in industrial demand of over 5 billion cubic feet by

1980 (6)(7). These data are presented in Table 6.

No provision was made for new industrial gas consumers. Montana Power Company has not accepted new industrial hookups recently nor is it planning to do so (7)(24). *Industrial growth in western Montana is not dependent on new supplies of natural gas.* Rather, other fuels are available (sometimes at lower long-range costs) for new industrial consumers. A Montana Power Company marketing executive expressed the company's policy toward new industrial consumers as follows (24):

> [W]e are not in a position to commit gas to new industrial process uses when we may have to curtail the existing industrial process gas use by our established customers. These customers have a considerable work force employed in Montana now and we are very conscious of the economic impact of the possible layoffs involved in any curtailment. We are also looking at the long-range protection of the natural gas supply to serve the residential, commercial and small industrial customers. These customers need natural gas for their basic space heating and cannot readily substitute other fuels for this purpose.

By the late 1980s most of the industrial consumers in western Montana will have converted from gas to other fuels where possible (7). The move to other fuels will be largely the result of higher gas prices. In addition to the planned industrial gas savings reported in Table 6, this report assumes that only one-eighth of the remaining conversion will occur by 1985, with an additional one-eighth occurring by 1990. This would reduce industrial demand by .81 billion cubic feet by 1985 and 1.6 billion cubic feet by 1990. Conservation of natural gas and conversion to alternative fuels by the industrial sector is expected to occur much faster than this and it is extremely unlikely to occur more slowly. In addition, it was assumed that non-substitutable gas demand would increase 2 percent annually through 1990. This ensures that new

TABLE 6

INDUSTRIAL NATURAL GAS SAVINGS PLANNED IN WESTERN MONTANA BY 1980

Company	1980 Gas Decrease (in mcf)	Explanation
ASARCO	10,903	Conservation
Anaconda Co. (at Anaconda)	3,000,000	Conversion to electric furnace
C & C Plywood	62,949	Conversion to wood wastes
Louisiana-Pacific (particle board)	25,000	Conservation
Ideal Cement	1,891,000	Conversion to coal
Kaiser Cement	1,695,000	Conversion to coal
TOTAL 1980 SAVINGS	5,044,561	Represents 20 percent of 1975 industrial natural gas demand of Montana Power Co. and Great Falls Gas

TABLE 7

EQC WORST CASE SCENARIO PROJECTED WESTERN MONTANA NATURAL GAS SHORTAGES, 1980-1990 (in billion cubic feet)

	1980	1985	1990
Demand	52.8	54.9	56.9
In-State Supply	22.0	17.0	12.0
Canadian Imports	29.2	25.6	----
SHORTAGE	1.6	12.3	44.9

industrial gas consumers will be able to receive gas in cases where substitutes are inappropriate. The combination of these data for Montana industrials, when combined with the 1.5 percent annual residental and commercial growth projections, yields the demand estimates presented in Table 7.

Supply in Western Montana

Montana Power Company expects to receive over 21 billion cubic feet annually during the next few years from in-state production (16). This estimate is based on MPC's ability to replace annual consumption and falling production from existing fields with new reserves. Current sources give the system approximately 16 billion cubic feet of gas annually. Also, the company's new Bearpaw holdings are expected to yield gas to the system in 1976. The total of current sources is expected to peak in 1978, declining in productivity by approximately one billion cubic feet per year thereafter.

MPC needs one to one-and-a-half years to put a developed field into its distribution system. This means in-state production additions to the MPC system can be revised upward within three years. Given the higher prices paid for new gas, which have resulted in a marked increase in exploration and reserves, and MPC's vigorous exploration program, it is not unreasonable to believe that in-state contribution to MPC's system will increase in the future. In fact, this is one way MPC believes it can solve its supply problems.

For this report, it has been assumed that MPC's present projections are accurate and will not have to be adjusted between now and 1980. After 1980, an additional one billion cubic feet decrease in annual contribution from in-state sources to the western part of the state has been assumed. These assumptions

are very conservative in that it is very likely that future in-state production will contribute much more than is assumed. Conversely, it is very unlikely that in-state production will contribute less.

MPC now receives 34.3 billion cubic feet of gas from Canada under a one-year permit which will expire in May 1977. The best estimate for Canadian import levels is contained in a letter to Lt. Governor Bill Christiansen from William Coldiron, MPC Executive Vice-President, stating (25):

> It would appear likely that on May 13, 1977, our imports from Canada will be cut to a rate of 29.2 BCF (billion cubic feet) annually. Assuming that there are no further curtailments by Canadian authorities, we would be at that level of imports until 1985. In 1985 the level would drop to 25.55 BCF annually and in 1986 the annual rate would drop to 14.6 BCF. The annual import volumes would remain at that rate until 1989. One of our licenses to export gas from Canada extends to 1993, but the licenses are subject to total export volume limitations. Since we have been taking gas at an accelerated rate in the last three years, we will reach the total volume limitations about the year 1989. <u>It appears that there will be no additional exports of gas from Canada authorized even when gas from the Arctic becomes available.</u>(emphasis added)

The future of imports from Canada is dependent upon how the Canadian government views its future supply/demand situation. The Canadian federal government has adopted a policy of self-reliance in natural gas, as well as other fuels. A general target of the <u>National Energy Strategy</u> is as follows (26):

> Given the need for Canadians to adjust to and adopt new conservation measures, given the long lead times for exploration and development, and for the provision of transmission and transportation facilities, given the enormous capital sums that must be deployed and given the need to focus this activity within a manageable time frame, the Government of Canada believes that we should set as our general target: energy self-reliance within ten years.

The specific targets are

- To reduce our net dependence on imported oil in 1985 to one third of our total oil demands.
- To maintain our self-reliance in natural gas until such time as northern resources can be brought to market under acceptable conditions.

The Government of Canada has many reservations about the development of frontier gas reserves (26). The announced reductions for gas exports to Montana are consistent with the above targets. However, if a shortage of gas should develop in Canada, it will be distributed between domestic and export customers, such as Montana, meaning even less will be available for export to Montana (26).

The EQC staff conducted interviews with people in and out of government in Canada and Washington, D.C. The concensus was that future exports of gas by Canada will not be increased (21)(27)(28). Worse, present Canadian policy would tend toward acceleration of the export curtailments. However recent increases in Canadian gas exploration and decreased growth in Canadian domestic gas demand may work to increase reserves and moderate present policy. The National Energy Board is conducting hearings, a part of which is to define the Canadian gas supply/demand situation once again (21)(28). This phase of the hearings (to be completed by December 1976) should tell the future of Canadian exports to Montana. Pending that redefinition, the consensus is that projections of gas export curtailments attached to current export permits form the best estimate of the rate of decline in Canadian import supply (21)(25)(26)(27)(28) .

The shortage for western Montana does not occur until 1980, even using the worst case analysis. At that time there would be a gap of 1.6 billion cubic feet between supply and demand. By 1990, this gap would grow to 44.9 billion cublic feet (see Table 7). This prediction assumes that nothing is done with

Montana policy to affect the future. Also, no consideration is given to price elasticity in the residential and commercial sectors. State production of gas was assumed to decrease even though the intrastate price will have doubled by 1977. With increased price one would expect increased production, which could add to the gas distributed by MPC by 1980. This shortage projection only allows for one-quarter of the feasible industrial conversions to other fuels by 1990. However significantly greater conversion is expected to occur by the late-1980s. Each of these assumptions is extremely pessimistic. It is unlikely these shortages will occur.

Supply and Demand in Eastern Montana*

MDU, in filing its curtailment plan with the Federal Power Commission, stated that it "must impose curtailments on its large industrial users in order to be able to keep (its) underground storage reservoirs at levels adequate to maintain service to existing and future high priority customers" (7) (emphasis added). "High priority customers" are residential and small commercial customers. Under this plan MDU would reduce supply to industrial comsumers so that it could add new residential and commercial accounts as well as supply present customers in these sectors. If no market curtailments were made MDU would expect to depletion of storage and occurrence of a shortage in 1981(7). If deliveries were made to present customers only MDU believes it could meet demand well into 1990s.

MDU's projections are for its entire service area, covering five states. These projections allow for new residential and commercial demand. However, many industrial consumers in the MDU service area have plans to convert from gas

*Montana-Dakota Utilities Service Area.

and to conserve energy (7). Conversion and conservation by 1980 will result in a 30 percent reduction in the 1975 industrial demand (see Table 8). When this information is combined with MDU's growth figures for residential and commercial sectors, the worst case demand can be estimated for 1980. After 1980, there will be widespread industrial conversion in Montana to other fuels. Most, if not all, of MDU's Montana industrial demand will have converted to other fuels where possible by 1985. *However, it is assumed that by 1980 these industrial consumers will not have changed to alternative fuels beyond changes already planned.* Again, these assumptions are extremely conservative and reflect the worst case approach.

To estimate the available supply, MDU's projections were used, which decreased similarly to the assumed MPC supply. It was assumed that the shortage predicted by MDU will be distributed equally over each state in its service area, in proportion to the amount of gas each state consumes. (Montana uses one-third of MDU gas.) With this assumption the total MDU supply predicted to be available to Montana is presented in Table 9.

Total Montana Shortage

The total Montana shortage, under the worst case approach, is 7.92 billion cubic feet in 1980, 26.25 billion cubic feet by 1985, growing to 73.9 billion cubic feet by 1990. (See Table 10.) *Between 1976 and 1980 no shortage is expected to occur.* MPC industrial customers have been assured adequate supply until 1983 (7); MDU, if its curtailment plan is approved, can meet demand well into the late 1980s (4). These worst case projections provide a very pessimistic background against which to compare alternatives. Shortages of worst case size

TABLE 8

INDUSTRIAL NATURAL GAS SAVINGS PLANNED IN EASTERN MONTANA BY 1980

Company	1980 Gas Decrease (in mcf)	Explanation
Farmers Union	157,174	Conversion to electricity
Continental Oil	496,740	Conservation
Great Western Sugar	1,217,836	Conversion to coal
TOTAL 1980 SAVINGS	1,871,750	Represents 30 percent reduction of total 1975 MDU industrial demand

TABLE 9

EQC WORST CASE SCENARIO PROJECTED EASTERN MONTANA
NATURAL GAS SHORTAGES, 1980-1990
(in billion cubic feet)

	1980	1985	1990
Demand	20.6	23.8	36.2
Supply	14.3	9.9	7.2
SHORTAGE	6.3	13.9	29.0

TABLE 10

EQC WORST CASE SCENARIO PROJECTED MONTANA
NATURAL GAS SHORTAGES, 1980-1990

(IN BILLION CUBIC FEET)

	1980	1985	1990
WESTERN MONTANA SHORTAGE	1.6	12.3	44.9
EASTERN MONTANA SHORTAGE	6.3	13.9	29.0
TOTAL SHORTAGE	7.9	26.2	73.9

have less than five percent chance of occurring. These projections assume that 1) residential and commercial consumers will not reduce consumption in reaction to dramatically higher gas prices; 2) among industrial consumers, it is assumed that by 1990 none will convert to alternative supplies in the MDU service area and only one-quarter will convert in the MPC service area, beyond what is already planned for 1980; and 3) in-state production will decline despite the doubling of intrastate prices and tripling of interstate gas prices. *These figures are in short, designed to show the largest demand and lowest supply which the state has to confront. With the alternatives available to Montana even these unrealistically large shortages can be met. With examination and choosing among alternatives, the worst case shortage need never occur. Montana can avoid the economic, social and environmental disruption that such a shortage would entail.*

ANALYSIS AND DISCUSSION OF ALTERNATIVES

Introduction

The post-1980 alternatives to Montana's impending natural gas shortage fall into two basic categories: actions which could decrease demand for gas (demand alternatives) and actions which could increase the supply (supply alternatives). The demand alternatives include conservation of gas through greater efficiency in use and conversion from gas to other fuels, generally fuel oil, wood wastes, coal, and electricity. In the following analysis, residential and commercial gas consumers are treated separately from industrial consumers in the demand alternatives because their basic needs for gas differ. Supply alternatives include increased state natural gas production dedicated to Montana use, manufacture of synthetic gas produced from Montana coal, use of gas from other states, and importation of gas supplied by an Arctic pipeline. Each supply and demand alternative will be analyzed according to the following nine factors:

1. The impact of the alternative on the demand for, or supply of, natural gas in Montana.
2. The length of the delay that can be expected before the alternative could have impact.
3. The certainty of the alternative's impact on supply or demand.
4. The cost to the consumer and to the state of pursuing the alternative.
5. The factors enhancing or hindering the pursuit of each alternative.
6. The impacts on supply and demand of a failure of an alternative solution.
7. Actions required to put the alternative into effect (implementation).
8. The side effects of implementing an alternative, positive and negative.
9. The conflicts with other state goals of pursuing an alternative.

Demand Alternatives: Residential and Commercial Conservation and Conversion

The residential and commercial sectors use most of their gas for space heating. It is relatively easy to conserve energy in space heating by improving the thermal efficiency of the heated area, using insulation for example. In contrast, it is much harder to convert residential and commercial space heating plants from one fuel to another. By improving insulation in homes and commercial buildings, a 40 percent reduction in fuel consumption could be achieved (29)(30). In homes this could be achieved by:1) fitting houses with storm windows and doors, 2) caulking and weather-stripping windows and doors, 3) insulating attics in existing houses and increasing the insulation in walls and ceilings of new ones (30). Similar techniques may be used by commercial customers to save energy. Montana Power Co. has issued information about energy conservation in residential housing. The company employs people trained in energy conservation techniques. The effect of the MPC conservation information program has not been determined.

With present prices and use patterns it is economical for residential and commercial gas customers to conserve energy by increasing thermal efficiency. The average Montana residential gas customer uses 105.2 MCF (thousand cubic feet) of gas annually, paying $15.96 per month for it in the Montana Power Co. service area (1)(2). Saving 40 percent by increasing thermal efficiency would conserve 41 MCF a year, or 3.42 MCF a month. The gas so conserved would have cost $5.91 per month, realizing a saving of $71.00 per year. If it cost $400.00 to install insulation to save the 40 percent, investment could be paid back in less than six years. The example illustrates what could be saved with residential conservation. If gas prices go up as expected

or incentives to insulate were offered to consumers, the payback period would be significantly reduced.

A 40 percent reduction achieved through conservation for all of Montana's residential and commercial consumers is unrealistic because:

1. All people would not insulate their homes or businesses. (Some people will not react regardless of economic or other incentives. This number of people is small.)

2. All people would not receive the same results. (Some would save more, others less. Well-insulated homes are a rarity because most homes were built when energy prices were low. People achieving more than 40 percent savings would balance out those who receive less.)

3. All people would not insulate effectively.

4. Initial capital is not available to some persons to purchase the needed equipment and materials.

5. Many people do not own their home, apartment or mobile home, so they would hesitate to spend money for capital improvements on someone else's property. A similar reasoning inhibits landlords from investing in energy conservation while tenants suffer the costs of utility bills.

Some of these problems can be mitigated by state government policy. For example, information and planning assistance can help citizens determine the optimum level of conservation for their property. The state could provide assistance (financial or otherwise) to utilities or supplement their efforts in other ways.

Initial capital is especially difficult for low and moderate income people to obtain. The money spent on conservation would be returned in the form of lower utility bills, but it still might be difficult to raise money necessary to install the equipment. A bill designed to meet this problem was passed by the 1975 Montana Legislature. It allows utilities to make loans at

7 percent interest to residential consumers to install energy conservation equipment. Great Falls Gas Co. has recently announced plans to implement such a program. Montana Power Co. rejected the program because, "1) such a utility program is not likely to succeed, and 2) in view of financial institutions, present capabilities and interests it is doubtful a utility loan program is needed"(31). Montana-Dakota Utilities Co. cited inexperience in making loans, competition with financial institutions and lack of funds as reasons for rejecting the idea (32).

This problem of raising capital for energy conservation could be alleviated by a low-interest loan program (with limits on loan amount), administered through lending institutions and financed by the state. The state might make interest free or low-interest loans to lending institutions which would like to be involved in the program, with the interest paid by the ultimate borrower to pay for the lender's administrative costs. Generally, tax breaks for people with low incomes are not adequate incentives since they pay little or no taxes. For commercial consumers or persons with moderate income, tax incentives would be a good way to encourage conservation. Because gas prices are rising partly as a result of governmental policy, it is equitable for the state to help mitigate this expense.

Incentives must be given to landlords to insulate their rental properties. Often landlords do not pay the utility bills, so even the economic incentive of rising prices does not apply. Examples of incentives to landlords for energy conservation would be tax breaks for installation of such equipment as well as requiring that a report of costs of utilities be included in leases and damage lists. (Damage lists are required by law; information about past energy use is easily obtainable from utilities.)

Recently Congress passed and the President signed the Energy Conservation and Production Act (P.L. 94-385). Within this new law are programs to assist states with energy conservation and use of renewable energy resources. Of particular relevance here are the "Weatherization Assistance for Low-Income Persons" and "National Energy Conservation and Renewable-Resource Demonstration Program for Existing Units."

The weatherization program has two aims: assisting low-income people to insulate their dwellings by aiding those least able to afford higher utility bills and conserving energy (33). The program gives the Energy Administration money for grants to States and Indian tribal organizations for the purpose of "providing financial assistance with regard to projects designed to provide for the weatherization of dwelling units" of low-income persons (33). The funds granted would be supplementary to any provided by the state and local governments. Generally, the cost of the federal participation is not to exceed $400 per unit.

Another section of the same act, "National Energy Conservation and Renewable-Resource Demonstration Program for Existing Dwelling Units," is designed "to test the feasibility and effectiveness of various forms of financial assistance for encouraging the installation or implementation of approved energy conservation measures and approved renewable-resource energy measures in existing dwelling units" (33). The program is to be conducted in cooperation with the states or citizen groups and includes extensive review of its own effectiveness. Grants to individuals under this program are limited to $400, or 20 percent of the cost of installing energy conservation measures (whichever is lower), and $2,000 or 25 percent of the cost of installation of renewable-resource measures, whichever is lower (33). There is, however, some flexibility to these limits.

Conceivably, Montana could use this federal assistance to implement the residential and commercial energy conservation alternative discussed here. Ten to 14 states are expected to be designated demonstration states to receive funding. If Montana is interested in receiving federal assistance for such projects, it should be prepared to provide its own incentives. The purpose of the Act clearly is to help states with energy conservation, not to do it for them.

Although the theoretical 40 percent reduction in gas used for space heating is not realistic as a conservation goal, a 30 percent reduction would be feasible by 1990. This estimate would be conservative if vigorous incentive programs were enacted. A 30 percent reduction (to be achieved by 1990) resulting from such an energy conservation program could save 10.05 billion cubic feet of 1975 residential and commercial demand. A 10 percent reduction in use of gas for residential and commercial space heating (to be achieved by 1980) would save 3.35 billion cubic feet annually. This latter reduction also could be achieved by the effect of rising prices but it would take five years longer.

The largest effect of an energy conservation program would require at least four to five years. After the initial push towards conservation the results will not be as dramatic. If few incentives are given, the results will be strung out over a long period of time. The biggest effect of a conservation program would occur before 1985. The estimated effect, plus the year in which the effect is achieved, is given in Table 11.

The conservation alternative is intended to save gas; however, if such a conservation program were enacted, but not limited to gas, one would expect similar savings in other forms of energy used for space heating, namely electricity and fuel oil.

TABLE 11

ESTIMATED IMPACT OF CONSERVATION ON EXISTING RESIDENTIAL AND COMMERCIAL NATURAL GAS DEMAND, 1980-1990

Impact Level	1980 (mmcf)	Percent of Residential and Commercial Demand	1985 (mmcf)	Percent of Residential and Commercial Demand	1990 (mmcf)	Percent of Residential and Commercial Demand
Estimated Impact of Conservation Program	3,348.4	10%	8,370.9	25%	10,045.9	30%
Maximum Impact of Conservation Program	5,022.6	15%	10,045.9	30%	13,393.5	40%

A conservation program also would increase employment opportunities for contractors, building supply houses, and carpenters. Most insulation can be installed by the home owner, but some would choose to have others do the work. Most commercial consumers would contract the work. This newfound employment would occur in every area of the state, urban and rural. More jobs would arise in lending institutions that might administer the loan program, to say nothing of jobs deriving from the original employment and spending.

Conversion from gas to other fuels by existing residential and commercial consumers would cost more and have less impact than a conservation program. Conversion to electricity currently is the most expensive, in terms of fuel costs. Conversion to solar heating for residences is high in capital cost yet very low in fuel costs. (Fuel expense would be incurred only for the necessary supplemental system used in cold weather.) Heat pumps are initally expensive but are more energy efficient than other forms of space heating. However, they are not very efficient in Montana's climate. All this is not to say that residential conversion to other fuels is not a good way to save gas, but, relative to the effect conservation can play in the short run, it is less important.

New Residential and Commercial Demand

In estimating the 1990 gas shortage, growth in residential and commercial uses of gas totaling 16 billion cubic feet was allowed. This amount could be substantially reduced with conservation practices applied to new housing and buildings. A 50 percent reduction from what is required to heat existing homes and commercial buildings could be achieved by energy conscious design (29). Reduced gas consumption is already encouraged by the uncertainty of gas supply and higher prices. Indicators show that many more all-

electric homes are being built (3). This trend could be strengthened by providing new buyers of homes and buildings with energy cost information and enacting new building standards.

The Energy Conservation and Production Act provides for new energy conservation standards for new buildings. Under the Act, only those buildings and houses which can meet new energy conservation standards to be promulagated by the Secretary of Housing and Urban Development can qualify for federal assistance, including all home loans from leading institutions, promulagated by the Secretary of Housing and Urban Development (33). These standards will be in effect no later than August 1981. Making state and local building codes meet the new standards is the responsibility of state and local governments.

Montana before August 1981 will be required to have building codes which are consistent with federal energy conservation standards, or force its citizens to do without mortgage loans from the state's financial institutions. If Montana adopts such standards now it can stimulate significant gas savings before 1981 .

Conservation measures and new design standards for homes and buildings would mean at least a 50 percent reduction over what was estimated in the shortage projection (30). Table 12 shows the savings achievable by energy conservation policies directed toward new residential and commercial demand.

With enactment of conservation incentives and building standards focusing on the residential and commercial sectors, gas demand in Montana would be substantially reduced. Federal assistance for such a program currently is available; and, for new buildings, it will be required. Montana could become one of the states leading the way in energy conservation and simultaneously receive federal help in doing

TABLE 12

ESTIMATED IMPACT OF CONSERVATION ON PROJECTED NEW RESIDENTIAL AND COMMERCIAL NATURAL GAS DEMAND, 1980-1990
(in million cubic feet)

	1980	1985	1990
WESTERN MONTANA	1,607.8	4,019.0	4,823.0
EASTERN MONTANA	748.8	1,858.3	3,110.5
TOTAL	2,356.6	5,877.3	7,933.5

TABLE 13

TOTAL ESTIMATED NATURAL GAS SAVINGS FROM RESIDENTIAL AND COMMERCIAL CONSERVATION, 1980-1990
(in million cubic feet)

ESTIMATED SAVINGS	1980	1985	1990
Existing Residential and Commercial Conservation	3,348.4	8,370.9	10,045.9
New Residential and Commercial Conservation	2,356.6	5,877.3	7,933.5
TOTAL PROJECTED SAVINGS	5,705.0	14,248.2	17,979.4

something especially beneficial for its citizens. The amounts of gas which could be saved are listed in Table 13.

Industrial Conversion to Alternative Fuels

Industrial conversion from gas to other fuels and conservation of gas could have a significant short-term impact on total gas demand. Through reports submitted to the Montana Public Service Commission and interviews with industrial gas consumer who account for more than 80 percent of Montana's industrial demand, the EQC staff found that over 11 billion cubic feet of gas consumption could be eliminated by industrial conversion from gas to coal, wood waste, electricity, or the use of waste heat at reasonable cost (6)(7). Many industrial consumers already have done engineering studies and detailed cost estimates of various conversion and conservation measures. The reasons given by most consumers of industrial gas for not converting now included the high capital costs and uncertainty concerning gas supply and price. Industrial consumers did not seem hesitant to spend money for conversion or conservation; however, they did not want to spend it unnecessarily. Only a very few industrials believed they would have to shut down and in those cases it was because they feared a shutoff of nonsubstitutable gas rather than a high price. Most industrial consumers believed they would convert to other fuels at some time, but indicated it would be prudent to wait.

Industrial consumers of gas in western Montana have an assured supply until 1983 (7). The price will be high, but it would be high for alternative fuels too. Generally, these industrial consumers do not feel confident about the future of gas supplies. Uncertainty, however, is not afflicting industrial gas consumers of eastern Montana, who have been told that gas simply will not be available for certain

uses, and that they must develop alternative fuel supplies (7). Eastern Montana industrial consumers of gas relying on MDU supplies are much closer to making final decisions about conversion to alternative fuels than those in western Montana. They have developed their contingency plans. Western industrial gas consumers also are planning, but not in as much detail as those in the MDU service area, because their problem is not so immediate.

Industrialists would like to have one to five years to convert from gas to other fuels. This lead time is helpful when having to order equipment, complete engineering plans, construct facilities, and contract for the alternative fuel supply. Lead time among industries varies with process and situation. Currently, there is no big rush to fuel conversion nationwide, so shortages of the necessary equipment are still problems of the future. However, if industrial consumers across the country started to convert to fuels other than gas, shortages of needed equipment would occur and lead times would have to be extended.

State governmental policy could have a significant impact on the rate at which industrial consumers convert from gas and move toward conservation. The industrial decisions on gas usage are based on economics, hence this could be the biggest area for governmental impact. Anything the state could do to make conversion to alternative fuels more economical could help decrease the industrial demand for gas. The EQC staff identified three areas where government could assist in reducing demand for natural gas:

1. Expand the present property tax incentives for energy conservation, Eliminate the $100,000 ceiling on the classification of property in Class 8 (15 percent assessment of market value). Expand exemption to include conversion from gas to more plentiful fuels.

2. Allow deductions in the corporate license tax for conservation and conversion to alternative fuels.

3. Provide low interest capital, either through the present municipal industrial development bonds or a similar program on the state level. The law currently allows for such low interest financing, which the state might enhance by grants to defer interest cost or guarantee the bonds.

The Energy Conservation and Production Act also has a program of loan guarantees for energy conservation or conversion to a renewable energy resource made by any person, state or political subdivision of a state. Included were industrial revenue bonds issued by municipalities to help finance industrial energy conservation and in some cases conversion.* If a program similar to the industrial revenue bonds were enacted on the state level, it also would be eligible for the federal guarantees. Bonds to pay for industrial conversion from gas to wood wastes would be eligible because they would be financing a change from a depletable resource (gas) to a nondepletable one, as required by the Act. Industrial conversion from gas to coal also may be included depending on how the regulations are drafted. It is clear, however, that Montana's industrial gas consumers could receive loan guarantee benefits under this program for energy conservation, through more efficient use of gas and conversion to wood wastes. This program, if combined with state benefits, would provide effective incentives for industrial consumers to convert from gas to more plentiful fuels.

These incentives, if enacted, should be self-repealing. This would alert the industry that it should move quickly. Review of the effect of such incentives by the Legislature would be very important to ensure the desired effects.

Total capital costs for the fuel conversion and conservation efforts needed to save 11.13 billion cubic feet would be approximately $56.8 million. Capital

*Individual companies would also be eligible for federal guarantees.

costs include all the equipment necessary to convert to the alternative fuel including pollution control equipment. Pollution control equipment accounts for a substantial portion of the total costs given and generally was considered a part of the price of burning coal and doing business today. The capital costs are listed in Table 14 with the amount of gas saved and lead time required by each company.

The data displayed in Table 14 identify 67 percent of the total substitutable industrial natural gas demand that could be saved by a combination of conversion and conservation. The remaining substitutable gas (approximately 9.7 billion cubic feet) could be converted to other fuels, but the total amount is uncertain. Incentives and natural gas prices will determine the timing of the conversions that will occur. The post-1980 EQC projections are based on the assumption that half of the remaining gas used as a boiler fuel (4.85 billion cubic feet) would be replaced by other fuels or otherwise conserved. Total gas savings from conversion and conservation, and year of impact are listed in Table 15.

The industrial gas consumers in the Missoula area are able to use wood waste for fuel beyond the readily available supplies. Hoerner-Waldorf, for example, could convert all of its boiler fuel gas demand to wood wastes. Sufficient supplies of wood wastes are not now available in Hoerner-Waldorf's estimation (34). (Wood waste comes from trees left after logging and from by-products of milling processes.) Supply bottlenecks on wood waste should be prevented. Also in the Missoula area, fuel from municipal waste has been identified as a potentially economical fuel and could supplement the supply of wood waste. Municipal refuse could be mixed with wood wastes in a hogged fuel boiler (7)(35)(36).

TABLE 14

ESTIMATED CAPITAL COSTS, CONSTRUCTION LEAD TIME, AND NATURAL GAS SAVINGS FOR SELECTED MONTANA INDUSTRIES CONVERTING TO ALTERNATIVE FUELS.

(NOT PRESENTLY PLANNED)

Company	Substitute Fuel Used	Capital Costs ($)	Amount of Gas Substituted (mcf)	Required Lead Time	Explanation
ASARCO	coal, waste heat	600,000	200,054	3 years	More gas might be converted, but in what quantities is not known
Borden	coal	500,000	36,000	3-4 years	
Louisiana-Pacific	wood wastes	500,000	109,000	1 1/2-2 1/2 years	Adequate supply of wood wastes is problem; coal may be potential alternative
Pfizer	coal	300,000 to 500,000	179,350	1-2 years	Not planning to convert at present time; would have to replace boilers and add handling equipment
Anaconda	?	3,000,000 to 3,500,000	2,000,000	3-5 years	Confronts safety and environmental problems
Hoerner-Waldorf	wood wastes, coal	31,200,000	4,000,000	5 years	Adequate supply of wood wastes is problem
	fuel oil	(uses present equipment)	(same)	hours	

TABLE 14 (continued)

Company	Substitute Fuel Used	Capital Costs ($)	Amount of Gas Substituted (mcf)	Required Lead Time	Explanation
Holly Sugar	coal	5,000,000	1,424,695	3 years	Can burn fuel oil now but not at higher cost; coal conversion would be cheaper over the long-term
	fuel oil	(uses present equipment)	(same)	hours	
Farmers Union	coal	3,000,000 to 4,000,000	1,495,090	3-4 years	
Continental	coal	7,000,000	1,627,555	3-4 years	Conversion to oil dependent on availability of Canadian crude.
	fuel oil	(uses present equipment)	(same)	hours	
Empire Packing	coal	300,000	62,000	3 years	Conversion dependent on market and gas supplies
	fuel oil	30,000	(same)	less than 3 years	
	electricity	(somewhere between coal and fuel oil)	(same)	3 years	
TOTAL		$56.8 million	11,133,744 mcf		

TABLE 15

ESTIMATED NATURAL GAS SAVINGS
BY INDUSTRIAL CONSERVATION AND
CONVERSION, 1980 - 1990

Year	Total Savings (Bcf)	Impact on Shortage Projections (Bcf)	Estimated Capital Costs (millions of 1976 dollars)
1980	4.125	4.125	21.3
1985	11.3	10.32	56.8
1990	15.98	14.36	81.3

A major side effect of direct use of fuels other than natural gas is the increased potential for air pollution. (Natural gas is a very clean fuel, one of the reasons it is so attractive to industrial consumers.) Air pollution could be kept within acceptable levels with responsible enforcement of present laws and standards. The industrial gas consumers interviewed by the EQC staff generally did not believe meeting air pollution standards was an unfair burden, but rather saw it as another cost of doing business. Missoula, Billings, and Anaconda have the greatest potential for new air pollution problems from fuel conversions, primarily because of their large industries. The industrial gas consumers interviewed in these cities were particularly aware of the potential air quality problems. The need for cooperative, broad based planning and regulation by Montana state government cannot be overemphasized.

Conversion from gas to other fuels between 1977 and 1985 is likely to have many effects beyond a reduced consumption of natural gas. These positive and negative effects are presented below:

<u>Positive</u>

1. Increased construction employment throughout the state to install necessary equipment.

2. Increased security and stability of Montana industrial economic base.

3. More employment to operate industrial facilities.

4. Enhancement of the competitive edge of Montana industry over others. Industrial gas consumers everywhere will have to find other fuel supplies or pay dramatically higher prices for gas. Montana industry could beat the rest to supplies of equipment and fuel by anticipating the problem.

5. Use of renewable energy resources (wood and municipal wastes) in place of nonrenewable resources.

Negative

1. Increased electrical demand. (However, Montana does have adequate supplies of electricity.)

2. Possible further degradation of air quality from industrial sources. Pollution could be minimized by responsible enforcement of existing laws, and by use of the best available pollution control technology. Air and water quality of course must be respected.

3. Continued reliance on limited (nonrenewable) energy sources (coal and coal-generated electricity). Alternative energy resources are being developed, yet they are not ready for industrial application. Conversion to alternative fuels and conservation efforts must bridge the gap between present technology relying on limited fossil fuels and the future of clean renewable energy resources.

Supply Alternatives: Increasing In-State Production

Montana's in-state production and exploration activity for gas reserves has been slow relative to other states in the northern Rocky Mountain region (2) (37) (38). The low level of production is a direct result of governmental policy reflected in high taxes and low prices for gas. Montana has good geological potential for gas but not as good as Alberta's or Wyoming's (15) (39) (40). Proven and undiscovered reserves could support Montana's 1974 level of consumption (twice that of current in-state production) for 23 to 100 years (39). This potential, though, will not be tapped if past policies persist. Policies more favorable to the Montana gas producing industry could increase supplies dramatically.

The average price paid for Montana gas historically has been the lowest, or among the lowest in the country (2). Low prices do not encourage exploration for new gas reserves. Because Montana has not been well explored, its known gas reserves are relatively small. Exploration activity rises with the general level of gas prices.

Estimates of natural gas reserves vary greatly. Many factors affect the

amount of gas included in any estimate. Reserve estimates generally hinge on the economics of gas production and the quality of geological information. Montana's reserve estimates for natural gas are low because of the low wellhead gas price and relatively unknown character of likely geological formations (39). Also, there are many types of reserve estimates, depending upon the nature of the reserve described. Montana has 930 billion cubic feet of proven gas reserves* (39) (40).

Three figures on undiscovered reserves give a good indication of Montana's gas potential (Table 16). Two of these figures are calculated from United States Geological Survey (USGS) data, the other is an update of those data made by geologists for the Montana Energy Advisory Council (39). The first estimate from the USGS (893 billion cubic feet) represents the amount of undiscovered, yet economically recoverable gas, with a 95 percent chance of existence. The second USGS estimate (2 trillion cubic feet) is the same kind of reserve figure but with a 50 percent chance (39). The first two estimates were made at the end of 1974, so recent economic changes and geological information are not included. The "steering committee estimate" (7 trillion cubic feet) is the combined judgment of a number of geologists working in the Montana gas industry; they adjusted the second USGS figure to include new information available since the end of 1974** (36) (39).

*Proven reserves are those which are economical to produce with today's technology and prices and are well identified.

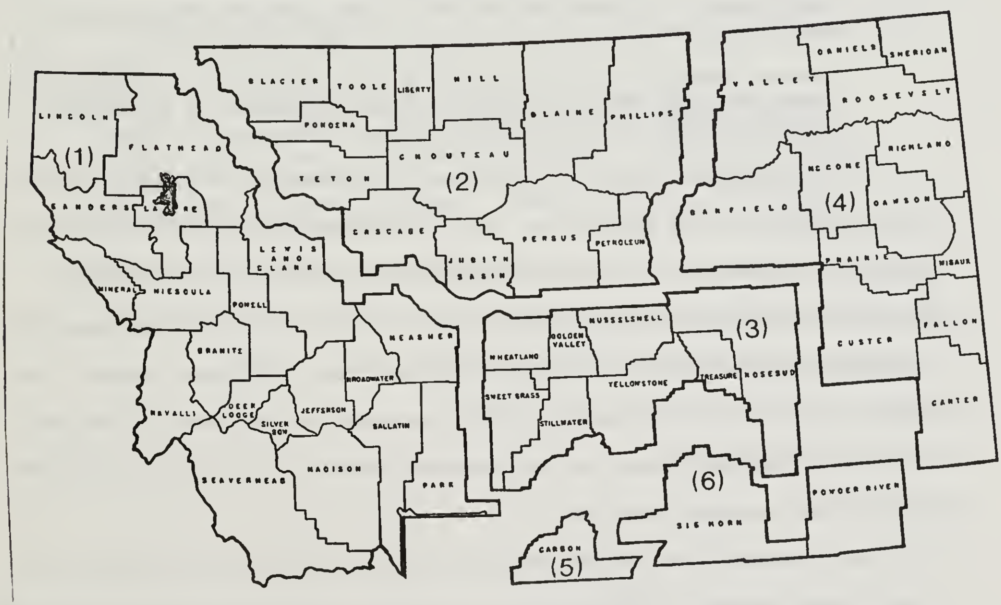
**Reserve estimates are based upon information which is updated almost daily as new exploration and geological data become available. Changes in reserve estimates are largely because of this flow of information.

TABLE 16

MONTANA UNDISCOVERED RECOVERABLE NATURAL GAS RESOURCE

(trillion cubic feet)

Region	USGS 95% Chance of occuring	USGS 50% Chance of occuring	Steering Committee
Montana Folded Belt	.2	.44 ± .19	5.00
Sweetgrass Arch	.5	1.09 ± .48	1.00
Central Montana Uplift	.05	.20 ± .16	.20
Williston Basin	.08208	.18 ± .08	.36
Big Horn Basin	.04764	.09 ± .03	.25
Powder River Basin	.0335	.02 ± .01	.25
Totals	.89307	2.02 ± .55	7.06
Years of Supply			
At 1974 Consumption	11 yrs.	25 yrs.	88 yrs.
Combined with Proven Reserves (930 BCF, 12 yrs.)	23 yrs.	37 yrs.	100 yrs.



(1) MONTANA FOLDED BELT
(2) SWEET GRASS ARCH
(3) CENTRAL MONTANA UPLIFT
(4) WILLISTON BASIN
(5) BIG HORN BASIN
(6) POWDER RIVER BASIN

The steering committee estimates are much higher than the others basically because of recent changes in economics and exploration. The Montana gas industry has become active only in the last few years. As the price for gas in Montana goes up, more reserves will become economical and will be included in future reserve estimates.

A July 1976 review of potential Montana natural gas reserves reached four conclusions (39):

1. Recoverable natural gas reserves and resources of Montana are between three and seven trillion cubic feet.

2. Reserves and resources of natural gas in Montana would be sufficient if developed to satisfy local consumption for between 37 and 87 years at the 1974 rate of consumption.

3. Development of natural gas resources could guarantee Montana self-sufficiency in natural gas for at least the next 20 years.

4. Current trends of price deregulation and leasing in the speculative areas would put the natural gas industry in Montana in a posiition to increase gas production and alleviate shortages.

A detailed survey of gas producers active in Montana conducted by the EQC staff revealed that the natural gas industry believes that low prices paid for gas and the high taxes on it are the two biggest obstacles to increased production from Montana reserves. This survey also shows that obtaining capital for Montana exploration was considered the third most inhibiting factor. Obtaining capital to risk on exploration is dependent on the chance of economic return on the dollars spent, so the financing problem is essentially a result of low prices and high taxes (15).

Even though wellhead prices for gas have increased in recent years, the price of gas relative to the cost of exploration has remained about the same (2) (38). This situation led one gas producer to comment: "While Montana (price

situation) has improved it is still far below states with competitive purchasers." The relatively low price is attributed largely to the lack of competition for buying gas reserves (15). Most gas producers feel that bidding for new gas is not competitive. One explained: "You have one intrastate buyer within Montana--Montana Power--no competition. Northern Natural Gas Company and Montana-Dakota Utilities have their interstate prices controlled by the Federal Power Commission, currently limited to $.53/MCF--no competition" (15).

Montana Power Co., the intrastate gas buyer, previously has not offered good prices to the producers. This is largely because of the availability of a gas supply for MPC from Canada. MPC was able to achieve higher return on its exploration and development dollar in Alberta than in Montana (16). History is prologue to many producers and it still affects MPC's buying situation today: many producers dislike dealing with MPC. As one stated (15):

> There is virtually no competition for gas in Montana. Montana Power has a monopoly in most areas and, through their consistant arrogant policy, has discouraged exploration. In those few areas where there is competition, producers will not sell to Montana Power if there is another market. Montana Power has no friends in the exploration business.

MPC has tried to overcome these hard feelings. The company's renegotiation of old contracts in 1974, which quadrupled the price of gas to 40 cents per thousand cubic feet, was a part of that effort (16). In spite of the dramatically increased prices paid by MPC, the intrastate buyer, many producers feel that the price is barely comparable with the regulated interstate price (15). (Interstate buyers generally pay a price that includes producers' taxes, while MPC does not.) Half of the producers surveyed said they believe that the intrastate price for gas usually exceeds that paid for interstate gas (15).

Producers still feel, though, that the intrastate price is too low (15).

The Montana Public Service Commission has regulatory authority over the Montana Power Co. and can limit the amount it pays for new gas reserves. By January 1977, MPC will have to pay $1.94 per thousand cubic feet for Canadian gas (14). MPC currently is paying 85 cents per thousand cubic feet for gas produced in Montana (15) (16). To compete with the new $1.42 interstate price, MPC believes it will have to pay around $1.60 per thousand cubic feet for gas produced in Montana (16). MPC should be allowed to pay prices for gas sufficient to ensure adequate and secure supplies of gas to serve the Montana consumer.

Reduction of taxes paid by gas producers is one of the most effective actions Montana could take to stimulate oil and gas exploration activity and increase reserves and production, in the eyes of the natural gas industry (15). Some of those contacted commented: "We have had prospective clients go to Wyoming, Utah and Colorado simply because of the Montana tax structure," and "In operating in ten states, the Montana tax burden is the worst by at least 200 percent" (15). Montana's taxes on gas, which differ from county to county, are much higher than surrounding states. Gas producers see taxes (in conjunction with low price) as the reason Montana has so much gas potential and so little production (15). What potential is tapped is determined largely by the tax and price situation.

Exploration managers and independent operators who make decisions of where to drill do so on economic grounds (41). These companies are very mobile and can afford to avoid a state that produces a lower return on their exploration dollars. The producers surveyed by the EQC staff, operated, on the average, in six states within the last three years. Some operated in as many as 20 or 30 states in that same period (15). These exploration managers and independent

operators say they prefer to drill in Wyoming and North Dakota for basically economic reasons (15). For Montana to compete for exploration dollars, it must make its economic climate at least comparable to that of other states.

The major variable which Montana can affect to increase gas exploration and production are economic factors (15) (41). Whether taxes are reduced or prices raised to offset such taxes, the effect must be to put more money into the gas exploration and production industry. These dollars could help finance further exploration and be incentives to drill in Montana. Montana's higher taxes could be offset by allowing deductions on corporate license taxes or simply by encouraging in-state utilities to pay higher prices.

The proposed new Federal Power Commission interstate wellhead price--$1.42 per thousand cubic feet--will do much to help Montana. If approved, this new interstate price would encourage explorers to look in "expensive" areas such as western Montana's overthrust belt, where exploration costs are among the highest in the world but the size of the reserves to be found is large (15) (39). MPC believes that it will bid around $1.60 per thousand cubic feet to compete with interstate pipeline companies. Natural gas industry spokesmen say that at $1.50 per thousand cubic feet, Montana's annual production could be increased by over ten billion cubic feet, to 55 billion cubic feet, and 65 billion cubic feet by 1985 (15). (Marketed production in 1974 was 43.7 billion cubic feet.) Much of this increase would be distributed in Montana if it were near intrastate gathering systems.

EQC producers' survey asked the gas industry what its response would be to a 1977 intrastate price hike to $2.00 per thousand cubic feet. The consensus was that exploration activity would increase dramatically which would be reflected in

reserves and distribution increases in a few years. At $2.00 per thousand cubic feet, most producers said 1980 annual production would be around 65 billion cubic feet and approaching 75 billion cubic feet by 1985 (1976 dollars, with taxes remaining the same). The prospect of $2.00 per thousand cubic feet wellhead price for gas brought comments such as these (15):

- $2.00 new gas would double or triple the drilling activity, since the density of drilling is in direct proportion to commercial wells discovered. There would be approximately a two-year lag from the time the wellhead price of gas was increased to $2.00 because it takes time to plan a vastly increased drilling program, contracting drilling rigs, drilling the wells, determining the reserves and putting commercial wells on production. It would be four to five years before the complete results of $2.00 gas would be known as far as reserve additions were concerned. If the interstate price remained substantially below the intrastate price most of the gas found would stay within the state.

- I believe exploration activity would increase by a factor of five, provided that other costs (drilling, material, etc.) does not keep pace with the increased price and provided further that taxes can be lowered or some sort of tax incentive enacted. I would expect that the production would be at the 55 bcf/year by that time and increase to at least 65 or 70 bcf by 1980. In as much as the area with the most potential lies in the area where there is no present interstate outlet, I would expect at least 75 percent to go to intrastate markets.

- It would be noteworthy, to say the least. Drilling activity would at least double and very easily triple in Montana. The entire impact of new production discovered would not be perceivable in that year as construction of pipeline gathering and transmission systems often take one or two years to be completed. 1977 production could rise to 55 billion cubic feet. I would estimate that 70 to 85 percent of the new reserves would go to the intrastate distribution.

Most of the areas with geological potential for gas and reserves are not accessible to the interstate gas market. Regions within the MPC service area received the top rating for undiscovered deep and undiscovered deep and undiscovered shallow reserves and for potential increases in existing reserves (15) (39). This indicates that much of the new gas available at higher prices would

be close to MPC distribution systems. With prices paid by MPC significantly higher than those paid by interstate distributors, MPC would receive 80 to 100 percent of the new gas.

Very large reserves, located close together are necessary to justify long extensions to pipelines. (A rule of thumb is .5 billion cubic feet of reserves per mile of pipe to be built.) Montana, far away from interstate markets, is usually not attractive to the large interstate pipeline distributors. However, if large reserves were found close together, there would be considerable competition between interstate pipeline companies and utilities that serve Montana. Who gets the gas is largely determined by price.

This report assumes that only 60 percent of any new gas would go to Montana distribution, even though intrastate prices would be much higher than interstate prices and interstate distributors do not have pipelines in the areas with the most potential. If taxes were reduced, a lower price would be sufficient to stimulate increased production (see Table 17).

In addition to stimulating increased natural gas supplies, government pursuit of a policy to increase in-state gas production would have several side effects:

<u>Positive</u>

1. Montana, even with reduced taxes on gas, would receive more total tax revenue from gas because production levels would be up.
2. Exploration for gas and construction of distribution lines would increase direct and indirect employment.
3. Money now going to Canada would stay in Montana.
4. Gas almost certainly would be less expensive than Canadian supplies.
5. The gas supply would be secure and adjustable to suit needs.

TABLE 17

ESTIMATED MONTANA NATURAL GAS PRODUCTION POTENTIAL

(in billion cubic feet)

	1980		1985		1990 2/	
Wellhead Price per MCF 1/	Annual Production	Increase to Montana Supply	Annual Production	Increase to Montana Supply	Annual Production	Increase to Montana Supply
$1.50	55	7.2	65	15.78	65	18.78
$2.00 3/	65	13.2	75	21.78	75	24.78
$2.50	75	19.2	85	27.78	85	30.78
$3.00	85	25.2	95	33.78	95	36.78

1/ Average price paid for new gas, computed in 1976 constant dollars.

2/ Assumes production levels off after 1985.

3/ Price used to estimate alternative's effect on natural gas shortages.

6. Tax incentives for gas would stimulate oil production, too. This would help Montana's refineries main crude oil supplies.

Negative

1. A large portion of the undiscovered gas reserve is in western Montana, including Glacier Park, wilderness areas and other pristine environments. Although initially a major conflict is avoidable, difficult choices will have to be made concerning what areas should be opened to drilling.

2. Accelerated gas production would require higher budgets for the Oil and Gas Division of the Department of Natural Resources and Conservation. The division regulates well spacing, salt water disposal, and reclamation of abandoned well sites. Although abuses are rare, enforcement is necessary. Higher budgets for this purpose would be inevitable.

Supply Alternatives: Synthetic Gas

Coal can be processed to synthesize gas of either low or high heating value (Btu). High-B or pipeline quality synthetic gas (1,000 Btu per cubic foot) is similar to natural gas used and produced in Montana. Low-Btu gas has certain industrial uses and has a heating value about one-fifth that of natural gas. A gasification plant would use Montana coal and water to produce high-priced synthetic gas for the state's consumers. Both low and high-Btu gasification technology have been examined by industrial gas consumers in the state but have been rejected except as a last resort (if natural gas were unavailable). Low-Btu gasification produces gas at a cost of $3.00 to $3.50 per million Btus. High-Btu gasification technology also is available for commercial application; prices for it range between $2.75 to $4.00 per million Btus. New technology promises to synthesize gas at an even lower price but so far is unproven. Federal assistance may be available to help finance the cost of a gasification plant.

Low-BTU Gasification

Low-Btu (100 to 150 Btus per cubic foot) synthetic gas can be used as a boiler fuel by most industries and has been closely examined by at least one Montana industrial gas consumer. It is not adaptable for residential and commercial use because it requires much larger pipelines than natural gas and uses different burners. Economical transportation is limited to short distances--not exceeding 25 miles. It was used in the 1930s and 1940s in 1,200 plants in the United States (41). Production from these plants stopped because the gas produced was more expensive than natural gas.

Prices for low-Btu gas range from $3.00 to $3.50 per million Btus. For comparison, industrial consumers paid 95 cents per million BTUs in 1975 for natural gas (2) (38) (41). One of the companies which examined the process in Montana expected to produce gas at a cost of $3.44 per million Btus (7). At that price, the synthetic gas would be used only if natural gas were unavailable or very expensive. The company's analysis showed conversion to alternative fuels and conservation were preferable options at this time.

Low-Btu technology is commercially available in the United States, but usually is custom built to produce large quantities of gas for high temperature processes. Montana's industrial gas consumers by and large do not need it. A low-Btu gasification plant is fairly reliable and can be constructed in 15 to 20 months.

The side effects associated with low-Btu coal gasification in Montana would be as follows:

Positive

1. Increased employment in areas where the process was used.
2. Stable energy supply to an individual industry.
3. Use of Montana's coal resource for Montana consumers.

Negative

1. High cost compared with alternative fuels.
2. High initial capital costs to construct the plant.

High-BTU Gasification

High-Btu gasification plants fall into two categories: first generation technology such as the Lurgi process and second generation or American technology (42). Initially a low-Btu process, the Lurgi gasification method now can be used to snythesize high-Btu pipeline quality gas. It is considered of commercial potential because there are several such plants in operation around the world, although none are located in the U.S. (42)(43). These small capacity plants in operation produce a low or medium-Btu gas (150 and 300 Btus per cubic foot respectively) and tests show that high-Btu gas can also be produced through a process called methanation (42). There have been technical problems, however, in scaling up the methanation process to plants of commercial size.

Eight gasification plants are being considered for construction in the United States. The Lurgi process is believed to be most favored (42). The first company to apply for approval was the El Paso Natural Gas Company for a plant to be built in the southwest. It was initially planned for completion in 1976; now the date of completion is indefinite. There have been delays in construction of another plant, also in the southwest. The other six plants are in various stages of planning. The uncertainty about these plants is the result of escalating costs,

delays, technological problems and cost overruns (42) (44).

Private investors have been hesitant to loan money for gasification plants because of the uncertain technology and problems with price competitiveness of synthetic gas. Synthetic gas will be at least $3.00 per million Btus if industry estimates are correct; however, some believe the price will be $4.00 per million Btus or higher (44)(48).

Since the first plants were submitted for approval, there has been rapid escalation of costs. For example, the El Paso Natural Gas Company plant was originally estimated for completion in 1976 at a cost of $250 million. By the end of 1975 no time was set for ultimate completion and capital cost had risen to approximately one billion dollars. Construction takes three to five years once all financial commitments and government permits are obtained. Capital costs for the plants have risen from around $400 million to approximately $800 million each. These plants are all using the Lurgi process, 250 million cubic feet per day capacity (commercial size). (See Table 18 for cost and date-of-completion estimates for these plants.)

Second generation technology is expected to produce 15 percent cheaper than the Lurgi process (44). It is not commercially proven but the Energy Research and Development Administration (ERDA) is funding research and the construction of a demonstration plant. (A demonstration plant is the step before commercial application.) ERDA expects this to be completed in four or five years (42)(49). Other second generation processes are not yet in the demonstration stage, but design studies are being funded. Many of these processes could use Montana coal.

Price for synthetic gas from a second generation plant is expected to range from $2.70 to $3.50 per million Btus (42) (44). The most often quoted price is

TABLE 18

HIGH-BTU COAL GASIFICATION PROJECTS
CAPITAL COST ESTIMATES

Project sponsor	Date when project completion and cost was estimated	Estimated project completion date	Estimated project cost (millions)
El Paso Natural Gas Company	Aug. 1971	1976	$250
	Nov. 1972	1976	353
	Oct. 1973	1978	491
	Dec. 1975	(a)	(Approximately $1 billion)
WESCO	Feb. 1973	b/1979	406
	June 1974	1979	447
	Jan. 1975	(c)	853
Michigan-Wisconsin	Mar. 1974	1980	450
	Apr. 1975	1980	d/778

a/ El Paso no longer projects a specific completion date other than it would occur 3 to 3-1/2 years after the date when all necessary approvals were obtained and financial arrangements completed.

b/ An earlier estimate projected that the plant could become operational in 1977.

c/ Construction was scheduled to begin in early 1976, but has not. WESCO currently claims that its project cannot proceed without Government incentives.

d/ Does not include capitalized interest during construction, which is expected to be provided on a current basis through a surcharge to Michigan-Wisconsin Pipeline Co. customers. This is subject to FPC approval.

around $3.00 per million Btus. However, if development of the Lurgi process is any example, the initial estimates will rise sharply. Federal funding for use of such technology in the near future may become available if legislation is passed.

Federal funding is doubtful because Congress is hesitant to invest public money into technology which synthesizes gas too expensive to sell. William A. Vogeley, a former deputy assistant secretary in the Department of Interior and now a mineral economist at the Pennsylvania State University, is against such funding (50):

> The United States is making large investments in research and demonstration plants to produce synthetic natural gas which may cost $3 to $4 per 1,000 cubic feet. Though no one knows how much natural gas remains in world reserves, this price is well above most estimates of its free-market price for many years to come.

He concludes that, "to force investment in major coal gasification plants at this time appears extremely risky. The private marketplace reacts to uncertainty by not investing and I would hope that the public marketplace would take the same kind of action" (50).

The second generation processes produce valuable by-products which can be used by petrochemical industries. If one such plant were located in Montana, it is possible that petrochemical industries would follow. Whether this would occur depends upon the types of process used, location of the gasification plant, and markets for goods produced by the petrochemical plant.

Two Montana industrial gas consumers have investigated producing synthetic gas for their own use (7) (47). Both believe that synthetic gas, at $3.50 to $4.00 per mcf, was priced beyond their reach. The Anaconda Copper Co. said this about its investigation of synthetic gas production (47):

> We regularly cost out S.N.G. (synthetic natural gas) whenever data becomes available. Most data come from ERDA funded projects. I am sure you are as aware of these as we are. A typical coal mine and S.N.G. plant cost is $200 million plus for pipeline quality gas. Our financial analysts have calculated such gas to be in the $3.50 to $4.00 per M.C.F. range.
>
> At this price, we have no immediate plans to produce S.N.G. ourselves. We prefer to concern ourselves with Natural Gas conservation and to support the drilling of deep wells in Montana to find new gas supplies. (emphasis added)

The Montana Power Co. has also investigated production of synthetic gas while looking into available sources of supply to meet its service area's demand in the face of Canadian curtailments of gas exports. In spring of 1975, Montana Power Co.'s President Joseph McElwain wrote Senator Mike Mansfield (45):

> Probably the most realistic source of gas for the future is the gasification of coal. The Company is working on plans that will lead to a gasification program. At this juncture, the road appears to be a formidable one. Environmental, water, mining and technological problems abound. The financial requirements for a plant are estimated to be between 750 million and one billion dollars. Montana Power might need up to one-half of the plant's output for its customers, and it is looking for partners to take the remaining gas. The gas will probably be priced at $2 to $4 per Mcf at the plant.

This policy statement was confirmed by correspondence from Montana Power Co. to the EQC staff, which read (46):

> I think that Mr. McElwain's statement in his letter to Senator Mansfield dated April 16, 1975, is a fair statement of Montana Power's current opinion on coal gasification. The time schedule of a "a minimum of ten years" is probably optimistic, in view of developments in the last year and one half. The plant investment required and the price of gas at the plant are also somewhat optimistic in view of current thinking.
>
> For the long term future it may be the only alternative if gas is to continue to furnish any substantial portion of Montana's energy requirements. Natural gas is a finite resource which will sooner or later be exhausted. The timing of the construction of a synthetic gas plant will depend to a large extent on the availability of natural gas from Montana, bordering states and Canada. (emphasis added)

The Governor's Coal Gasification Task Force, with the assistance of the Montana Trade Commission, is reviewing high-Btu gasification processes suitable for Montana. The Task Force, through the MTC, has arranged for engineering firms familiar with gasification technology to determine the best process available, cost of the synthetic gas produced, and capital costs (51). It also is examining financing for such a plant, including obtaining funds from federal, state and private sources. Studies concerning demand for synthetic gas, environmental impacts and siting problems also are being conducted (51). The work is to be available for review in November 1976. Currently the MTC appears to favor a second generation demonstration plant because federal funding is likely to be available. The plant would require six to seven years' lead time before full production.

Montana Power Co. has expressed an interest in a joint-venture gasification project with the Montana International Trade Commission "if it is technically, economically, legislatively and otherwise feasible for us to do so" (46). Montana-Dakota Utilities Co. was involved at one time in a gasification project in Wyoming, but it is not known whether it would be interested in one now (51)(52).

A commercial-size gasification plant would produce 250 million cubic feet of gas per day or approximately 75 billion cubic feet annually (42). This would be more gas than Montana would need even by 1990, using the EQC worst case estimates. Some of this gas could be distributed interstate but there are no distribution lines from Montana to major gas markets at this time. If a market could be identified, gas pipelines could be built; or if an Arctic pipeline were constructed, the gasification plant could be connected to that system. A smaller

unit is being examined by the Task Force--a plant with a capacity of 180 million cubic feet per day and annual production of more than 54 billion cubic feet (51). This is more than would be required to meet the shortage identified in the EQC 1990 worst case scenario. A demonstration plant, also considered by the Task Force, would produce approximately 27 billion cubic feet of synthetic gas per year.

Some of the major impacts associated with the construction and operation of high Btu gasification facilities are listed below:

<u>Positive</u>

1. Increased employment in construction and operation (limited to the plant site).

2. Very stable gas supply if the plant works satisfactorily.

3. Use of Montana's coal resources for Montana consumption.

4. Petrochemical plants, if sited with the plant, would provide jobs in construction and operation (again this is limited to the plant site).

<u>Negative</u>

1. High priced gas source. Federal funding would decrease the price considerably but probably not below $2.50 per million BTUs.

2. The technology if applied within the next three to five years would be outdated before the useful life of the plant expired. New technologies promise to produce gas at much lower cost than those which are available currently.

3. Capital costs are very high and may go up. Even with federal and private funding the capital costs would be very large.

4. Proven technology is not in operation today and there may be delays in construction and operation of such a plant. If the plant had to be shut down for any extended period, Montanans would be without a substantial portion of their gas supply.

5. Any excess capacity of the plant would be difficult to market.

Interstate Gas Supplies

Montana also could receive gas supplies from other states in the Rocky Mountain region. These supplies would not be vulnerable to restrictions as are Canadian imports. Interstate gas prices are regulated by the Federal Power Commission which also must approve transport from one state to another. More gas could be obtained, specifically from Wyoming and North Dakota.

Utilities serving Montana are small relative to the major pipeline companies which operate in Wyoming. These gas distribution utilities, such as Northern Natural Gas and Colorado Interstate Gas Company serve areas with large demand for gas and are willing to pay the highest allowed price for new production. Often these utilities offer producers large, interest-free advances of capital (sometimes several million dollars) to help pay for development of gas reserves. A number of large distributors have pipelines in Wyoming and bid competitively for the new reserves found there. Montana's relatively small demand for gas often is dwarfed by the size of the reserves up for bid. For example, in 1976 a new discovery in Wyoming had more reserves than the entire state of Montana. On such large finds, Montana's utilities could enter into joint ventures to distribute costs.

The price of interstate gas, although regulated at $1.42 per thousand cubic feet, would cost more than $2.00 to $2.50 when delivered at the Montana border. Even at this price, interstate gas would be more secure than Canadian gas imports since once established the supply is stable.

Arctic Gas Supplies

There are a number of proposals to bring gas from Alaska to the continental United States. A few of these proposals foresee pipelines which would run through

or very near Montana. Other proposals include a sea route, the gas being liquified in Alaska for transport by ship to the northwest. Each of these proposals is under consideration by a number of governmental bodies; an initial decision is not expected for a few years. A pipeline would not be constructed before 1985 in any case.

If a pipeline route were chosen across Canada, permission would have to be obtained, causing more delay. Also each Canadian province through which the pipeline passed would be able to tax the gas, unless a treaty or other agreement with Canada forbade it. This would cause further delays. Even ignoring the provinces' power to tax, Arctic gas would be as expensive as synthetic gas, that is, $3.00 to $3.50 per thousand cubic feet.

Montana Power Co. has an agreement with Pacific Gas and Electric Co. to purchase a portion of the gas the latter firm will receive from the Arctic (53). MPC estimates that it might be permitted to buy up to 15 billion cubic feet annually of Pacific Gas and Electric Co.'s gas from the Arctic pipeline (45). Whether or not Montana receives this gas depends on the final route of the pipeline, the timing of delivery of gas, and its price. MPC has contacted all of the companies that are considering transporting Arctic gas, but it has not been told anything definite (53).

COMPARING ALTERNATIVES

In this section each alternative is summarized and compared. Table 19 presents a "scoreboard" in which each alternative is assessed according to three criteria:

1. Impact on increasing supply or decreasing demand
2. Cost to the consumer
3. Cost of failure

In addition to this scorecard, Tables 20 through 24 summarize each alternative according to eight criteria:

1. Estimated impact on the shortage (decrease or increase)
2. Required lead time
3. Certainty of the impact
4. Cost to consumers
5. Factors which enhance or inhibit the alternative
6. Possible implementation strategies
7. Positive and negative side effects of the alternative
8. Conflicts with other state goals in pursuing the alternative

Least Cost Alternatives

One consideration which should be paramount in deciding which mix of alternatives should be pursued is cost. If one desired to provide the lowest possible price for the service natural gas provides to consumers, the alternatives would rank as follows:

TABLE 19 . MONTANA GAS SUPPLY CRISIS: ALTERNATIVES SCORECARD

	WORST CASE SHORTAGE	RESIDENTIAL AND COMMERCIAL CONSERVATION	INDUSTRIAL CONSERVATION AND CONVERSION	INCREASED IN-STATE PRODUCTION	LOW-BTU GASIFICATION	HIGH-BTU GASIFICATION	INTERSTATE GAS SUPPLIES	ARCTIC GAS SUPPLIES
Increased Supply or Decreased Demand:* 1980:	7.92 Bcf	-5.7 Bcf	-4.125 Bcf	\$1.50+7.2 Bcf 2.00+13.2 2.50+19.2 3.00+25.2	Depends on individual industrial demand and situation	None	Depends on utilities' ability to obtain gas in highly competitive markets.	None
1985:	26.25	-14.25 Bcf	-10.32 Bcf	\$1.50+15.78 Bcf 2.00+21.78 2.50+27.78 3.00+33.78	same as above	+75 Bcf +54 Bcf +27 Bcf	Depends upon need for gas and desire to pay the price. (15 Bcf)	
1990:	73.9	-18.0 Bcf	-14.36 Bcf	\$1.50+ 8.78 Bcf 2.00+24.78 2.50+30.78 3.00+36.78	same as above	same as above	same as above	
Cost to the Consumer:	Much higher utility bills, short term job layoffs because of lack of gas supply. Short term industrial shutdowns.	Net economic benefit.	Net economic benefit	Slight decrease from Canadian prices. Eastern Montana slight increase.	\$3.10 to 3.50 per million btus.	\$2.75 to 4.00 per Mcf or million btus.	\$2.50 to 3.00 per Mcf	\$3.00 to 3.50 per Mcf
Cost of the Alternative's Failure	Not applicable	Can be monitored quarterly and yearly. Upon signs of failure policy can be strengthened or other alternatives stimulated.	Impact can be predicted 1 to 2 years in advance. Can be readjusted or other alternatives stimulated.	Can be monitored continually. Failure can be seen very quickly and incentives strengthened.	Jeapordizes industrial supply for individual companies.	Failure can only be seen during final engineering and construction phases. Jeopardizes substantial portion of total supply.	Once gas is bought, supply is assured. Delays in transmission would have impact on small part of total supply	May be permit delays. Decision for pipe-line route, timing and cost all out of MT state government hands.

*-means decreased demand
+ means increased supply

TABLE 20. ANTICIPATED EFFECTS OF RESIDENTIAL AND COMMERCIAL CONSERVATION
(Existing and New Demand)

ESTIMATED DECREASE IN DEMAND	LEAD TIME	CERTAINTY OF THE IMPACT	COST TO THE CONSUMER	FACTORS ENHANCING THE ALTERNATIVE	IMPLEMENTATION	SIDE EFFECTS: POSITIVE	CONFLICTS WITH OTHER STATE GOALS
1980: 5.7 Bcf 1985: 14.2 Bcf 1990: 18.0 Bcf	If the incentives were limited to a certain period of time, most of the impact would occur within that period. Three to five years should be given for maximum effect to occur. New building standards should be studied, designed and enacted before 1981.	The listed impact is relatively certain. It depends upon the price of gas and the incentives for conservation as well as the technical assistance provided.	It is economical now to insulate. A person would save money from lower utility bills, which pays for the cost of insulation. Conservation would pay for itself in a short period of time. *Net benefit to the consumer.*	1. The price of gas now, as well as the expected price increases. 2. Conservation technical assistance and information is already provided by utilities. INHIBITING 1. Insufficient technical assistance to ensure maximum economic conservation. 2. Initial capital problems for residentials. 3. Many people do not own their homes, hence they are hesitant to make capital improvements.	1. Technical assistance from energy extension service. Also, supplement utilities' efforts. 2. Low-interest loan program to residentials. 3. Incentives to landlords to conserve energy. Tax incentives and low cost loans for insulation. Also require energy costs as part of renting transaction. 4. New building standards geared to efficient energy use. 5. Providing purchasers of new homes and buildings with information on energy cost. 6. Federal assistance is available for implementation of energy conservation programs such as these.	1. Increased employment for contractors, building supply houses, hardware stores and carpenters throughout the state. 2. Increased employment within lending institutions administering program. 3. Would also receive savings in electricity and fuel oil used for space heating. 4. Since consumers will benefit monetarily, increased spending will occur in the general economy. NEGATIVE 1. Effective conservation program would cause gas prices to rise.	None

TABLE 21 . ANTICIPATED EFFECT OF INDUSTRIAL CONSERVATION AND CONVERSION
(Not Already Planned)

ESTIMATED DECREASE IN DEMAND	LEAD TIME	CERTAINTY OF THE IMPACT	COST TO THE CONSUMER	FACTORS ENHANCING THE ALTERNATIVE	IMPLEMENTATION	SIDE EFFECTS: POSITIVE	CONFLICTS WITH STATE GOALS
1980: 4.125 Bcf 1985: 10.32 Bcf (11.3 Bcf total conversion minus .811 assumed MPC 1985 conversion) 1990: 14.36 Bcf (15.98 Bcf Total conversion minus 1.622 Bcf 1990 assumed MPC conversion)	Depending on the company, lead times vary from one year to five years. Five to seven years are assumed here.	The initial 11 Bcf impact can occur given the right incentives and lead time. Incentives change the timing of conversion. Effects can be monitored quarterly or yearly. Impact will be known 1 to 2 years in advance.	The way a company converts from gas will be dictated by economics. The conservation and conversion will occur when it becomes economical to do so. Incentives will simply make it economical sooner. *Net benefit to the industrial consumer.* Approximate capital costs 1980: $21.3 million 1985: $56.8 million 1990: $81.3 million	1. The high price of gas relative to other fuels. 2. The uncertainty of supply will cause some to convert sooner. INHIBITING 1. The high capital cost of conversion. 2. Uncertainty of supply. Some believe that gas will be available in the future.	1. State guarantee of municipal bonds for conversion and conservation. 2. Write-off of interest paid under these bonds over 5 percent. 3. Deductions for conservation and conversion from the corporate license tax. 4. Eliminate $100,000 ceiling on class 8 property evaluation; amend to include conversion from gas to other fuels. 5. Use Federal loan guarantees as added incentive.	1. Increased construction employment throughout the state. 2. Increased security of Montana's industrial base. 3. Added employment to operate the new equipment. 4. New capital to existing plants increasing property tax. 5. Use of renewable energy resources in place of nonrenewable ones (conversion to wood wastes from gas). NEGATIVE 1. Increased electrical demand. 2. Possible air pollution from conversion. 3. Continued reliance on non-renewable resources.	*Air quality would be reduced in industrial areas. However, these levels of pollution would still be within present standards.* 4. Increased gas price because fixed costs are distributed over lesser quantity.

TABLE 22. ANTICIPATED EFFECT OF INCREASED IN-STATE PRODUCTION
(For In-State Consumption)

ESTIMATED INCREASE IN SUPPLY	LEAD TIME	CERTAINTY OF THE IMPACT	COST TO THE CONSUMER	FACTORS ENHANCING THE ALTERNATIVE	IMPLEMENTATION	SIDE EFFECTS: POSITIVE	CONFLICTS WITH OTHER STATE GOALS
1980: Bcf/Yr. $1.50/mcf 7.2 2.00/mcf 13.2 2.50/mcf 19.2 3.00/mcf 25.2	Initial impacts known within one to one and a half years from policy changes.	Longer term (post-1990) results are more speculative and depend upon success in expoloration.	Western Mt.: Canadian gas to cost $1.94/mcf Jan. 1, 1977. These prices are less, hence a net benefit. Present gas cost 85¢/mcf within Mt.	1. As result of the proposed FPC price, increased intrastate bidding will approximate the $1.60/mcf level.	1. Lower taxes to be comparable with other states. 2. Price gas roughly equal to Canadian border price.	1. Montana,even with reduced taxes on gas, would receive more tax revenue because production levels would be higher. 2. Exploration for gas and construction of distribution lines would increase primary and secondary employment.	*Hard decisions will have to be made about what areas are open to exploration.*
1985: Bcf/Yr. $1.50/mcf 15.7B 2.00/mcf 21.78 2.50/mcf 27.78 3.00/mcf 33.78	Five to six years before full impact is achieved.	Near term (pre-1985) relatively certain of achieving that amount of gas.	Eastern Mt.: Would increase cost to eastern Mt consumers. However, proposed FPC price is $1.42/mcf and these prices are higher than that level.	2. Good possibility of large success in certain regions; however, very expensive to explore these areas.	3. Give tax incentives for drilling in high risk areas.	3. Money now going to Canada would stay in Montana.	
1990: Bcf/Yr. $1.50/mcf 18.78 2.00/mcf 24.7B 2.50/mcf 30.78 3.00/mcf 36.78	Results from incentives can be monitored quarterly and yearly from time of policy change.	This level of production can be maintained for at least 25 years. (95% chance exists that reserves are sufficient to maintain that production level.)	(All prices given at the wellhead.)	INHIBITING 1. The present low price relative to other states in region. 2. Taxes are higher than in other states in the region. 3. Risk capital is harder to obtain for MT exploration than for other states.		4. Gas supply would be secure and adjustable to suit needs. 5. Tax incentives for gas would stimulate oil production too. This would help Mt's refineries maintain crude oil supply. NEGATIVE 1. A large portion of the gas reserves are in western MT, under Glacier Park, wilderness areas and other pristine areas. 2. Would require higher budgets for the Oil and Gas Conservation Division, DNR.	

TABLE 23. ANTICIPATED EFFECTS OF LOW-BTU GASIFICATION

ESTIMATED INCREASE IN SUPPLY	LEAD TIME	CERTAINTY OF THE IMPACT	COST TO THE CONSUMER	FACTORS ENHANCING THE ALTERNATIVE	IMPLEMENTATION	SIDE EFFECTS POSITIVE	CONFLICTS WITH OTHER STATE GOALS
Supplies individual industrial customers, rather than substitute fuels or where substitute fuels are not practical.	One to two years are required to construct a plant.	Proven technology in use in the United States today.	$3.00 to $3.50/ million Btu's. One Montana industrial gas consumer estimated price: at $3.44 per million Btu's. (A million Btu of low-Btu gas is roughly equivalent to a thousand cubic feet of natural gas.)	1. The uncertainty of natural gas supply. 2. The price of gas makes it more economical although still too costly. INHIBITING 1. Availability of lower cost alternatives if gas is available at all.	Same as in INDUSTRIAL CONSERVATION AND CONVERSION with expansion to include Low-Btu gasification plants in class 8 property evaluation.	1. Clean fuel for industries. 2. Increased employment in areas where the process is used. 3. Stable energy supply to individual industries. 4. Use of Montana's coal resources for Montana's consumers. NEGATIVE 1. High cost compared with alternative fuels. 2. High initial capital costs to construct plant.	None

TABLE 24. ANTICIPATED EFFECTS OF HIGH-BTU GASIFICATION

ESTIMATED INCREASED IN SUPPLY	LEAD TIME	CERTAINTY OF THE IMPACT	COST TO THE CONSUMER	FACTORS ENHANCING THE ALTERNATIVE	IMPLEMENTATION	SIDE EFFECTS: POSITIVE	CONFLICTS WITH OTHER STATE GOALS
Commercial size: 250 MMcf/day approximately 75 Bcf/yr	5-6 years	1st generation technology: none operating today in the U.S.	1st generation: $3.00-$4.00/mcf 2d generation: $2.75-$3.00/mcf (conservative)	1. Uncertainty of obtaining gas supplies at any price. 2. Federal funding for such projects.	Funding could be provided by state, federal or private sources or any combination of these.	1. Increased employment in construction and operation of plant. (limited to the plant site) 2. Very stable gas supply once the plant is in operation. 3. Use of MT's coal resource for Montana consumers. 4. Petrochemical plants, if sited, would provide jobs in construction and operation. (Also limited to plant site.)	Construction of a facility for instate use, with state government involvement may open door to construction of facilities for interstate use. May conflict with state energy policy in the future.
180 MMcf/day 54 Bcf/yr	5-6 years	Technical problems have been encountered	All prices given are gas at the plant site. Lower prices may be possible with Federal funding which is dependent upon new legislation. Montana industrials' estimate $3.50-4.00 per million BTU's.	INHIBITING 1. Availability of lower cost alternatives. 2. Technical risk of unproven technology. 3. Lead time necessary is uncertain. 4. High capital costs for such plants.		NEGATIVE 1. High priced gas source. 2. Technology if applied within the next three to five years may be outdated before the useful life of the plant expired. New technology promises to produce gas at lower cost than those which are currently available.	3. Capital costs are very high and may go up. Proven technology is not in operation today and delays would jeopardize large portions of Montana's supplies of gas
Demonstration size: 27 Bcf/yr	7-8 years	2d generation technology; problems may be encountered during design and construction, hence the longer lead time.					

First : Industrial conservation and conversion
Residential and commercial conservation

Second : In-state production for in-state use

Third : Interstate gas for Montana use

Fourth : Gasification of coal
Arctic gas

Policies designed to achieve the lowest possible price would simultaneously seek to implement the demand alternatives in conjunction with increasing in-state supplies of natural gas for in-state use. The goal here would be to ease the present tight supply situation which drives prices beyond what would be necessary in a market equilibrium situation. This could be accomplished by 1) decreasing demand by providing market incentives to consumers to conserve and convert to more plentiful fuels and 2) increasing supply by offering a market price for natural gas equal or nearly equal to what is paid for Canadian natural gas imported to Montana.

Alternatives Providing Most New Employment

Although the price paid by the consumer is important, new employment for Montanans is also a factor to be considered. If two alternatives provide additional supplies of gas at approximately the same price and one alternative produces a large number of new jobs while the other does not, the alternative providing the most new jobs should be preferred. If one wanted to provide maximum new employment, the alternatives would rank as follows:

First : High-Btu gasification (limited, however, to one area of the state with many jobs being temporary construction employment)

Second : In-state production for in-state distribution (employment here would be distributed throughout the state)

Third : Industrial conservation and conversion
Residential and commercial conservation
Low-Btu gasification (construction employment would be spread over time and throughout the state. Small net increases in operating personnel.)

Fourth : Interstate supplies of natural gas
Arctic gas

Policies designed to produce maximum new employment would pursue the demand alternatives and all of the supply alternatives except increasing interstate and Arctic supplies. This combination would provide Montana with gas far beyond what is required to meet in-state demand, so most of the gas would have to be marketed to other states. In addition, this mix of alternatives would provide gas at a higher price than what would prevail if the least cost alternative were selected.

Alternatives with Maximum Certainty

Neither the least cost nor the maximum new employment alternatives would be worthwhile if their impact upon the projected natural gas shortage did not occur. Certainty of an alternative's impact should be examined along with other criteria. If one wanted to achieve maximum certainty, the alternatives would rank as follows:

First : Industrial conservation and conversion

Second : In-state production for in-state use
Residential and commercial conservation
Low-Btu gasification

Third : Increasing interstate supplies
High-Btu gasification

Fourth : Arctic gas

Conclusion: Mixes of Alternatives

No single alternative can prevent the worst case shortages. Some combination of demand and supply alternatives will be required to meet the 1990 worst case shortage projections. A combination of alternatives, however, can provide effective solutions to Montana's natural gas supply crisis. If it pursued all the alternatives, Montana could have natural gas supplies exceeding the 1980 and 1985 shortages by three times.

Figures 8 and 9 illustrate Montana's natural gas supply and demand situation, comparing the EQC worst case shortage projections and the contribution to supply made by all alternatives. This combination provides the range within which Montana, through decisions and policies, can affect its future.

Figure 10 shows that by combining the demand alternatives the state could meet the 1980 shortages and nearly meet the 1985 worst case shortages. Over time, these alternatives provide consumers with a net economic benefit. However, the demand alternatives would only prevent 44 percent of the 1990 projected worst case shortages.

When combined, the supply alternatives provide sufficient gas in the early 1980s, with a slight shortage occurring before 1985 (see Figure 11). Assuming the contribution of high-Btu gasification and Arctic gas occurs by 1985, a large surplus is created lasting to the late 1980s. By 1990, the supply alternatives, even when combined, cannot prevent a shortage. However, this shortage could be eliminated by storing the excess gas produced earlier in the period. With this storage, the supply alternatives probably would provide enough gas to prevent a shortage through 1995.

The demand alternatives, when combined with in-state production, would

figure 8

EQC WORST CASE PROJECTIONS, 1980-1990

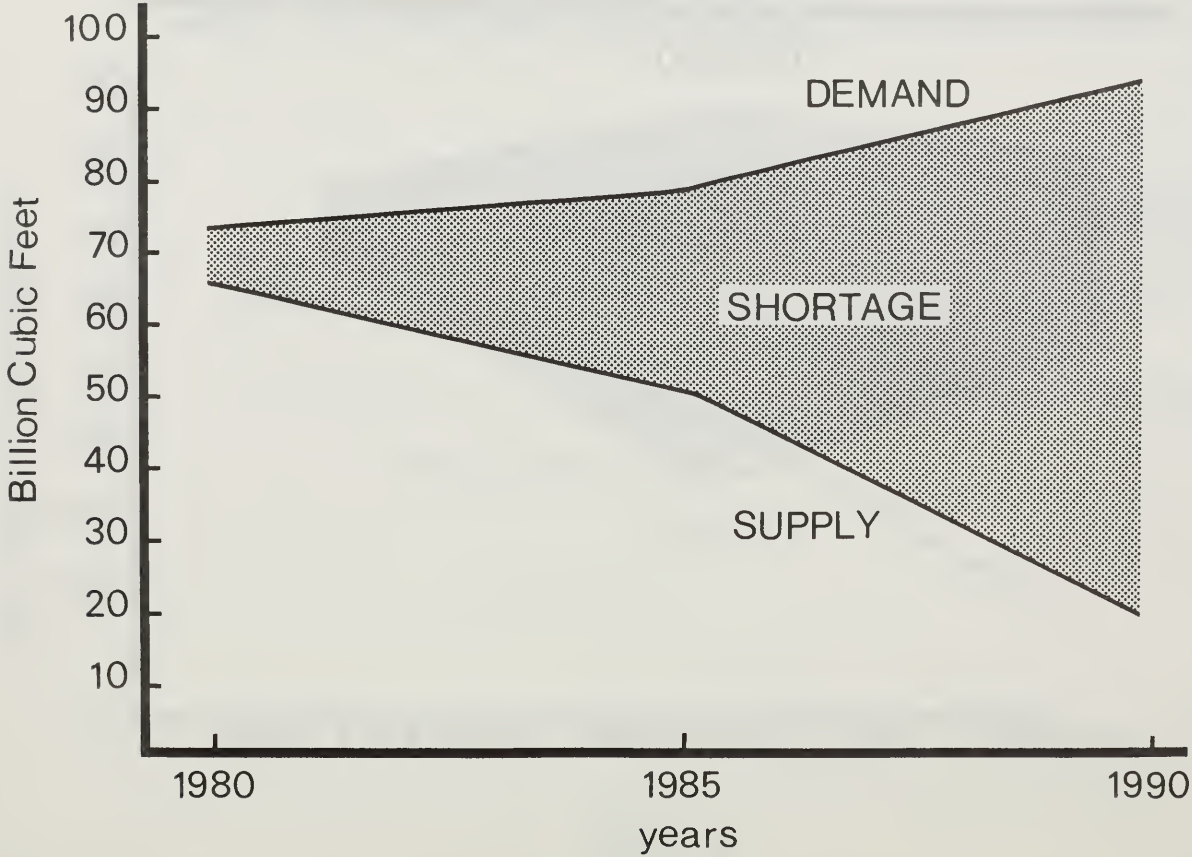


figure 9

EQC MAXIMUM CASE PROJECTIONS, 1980-1990

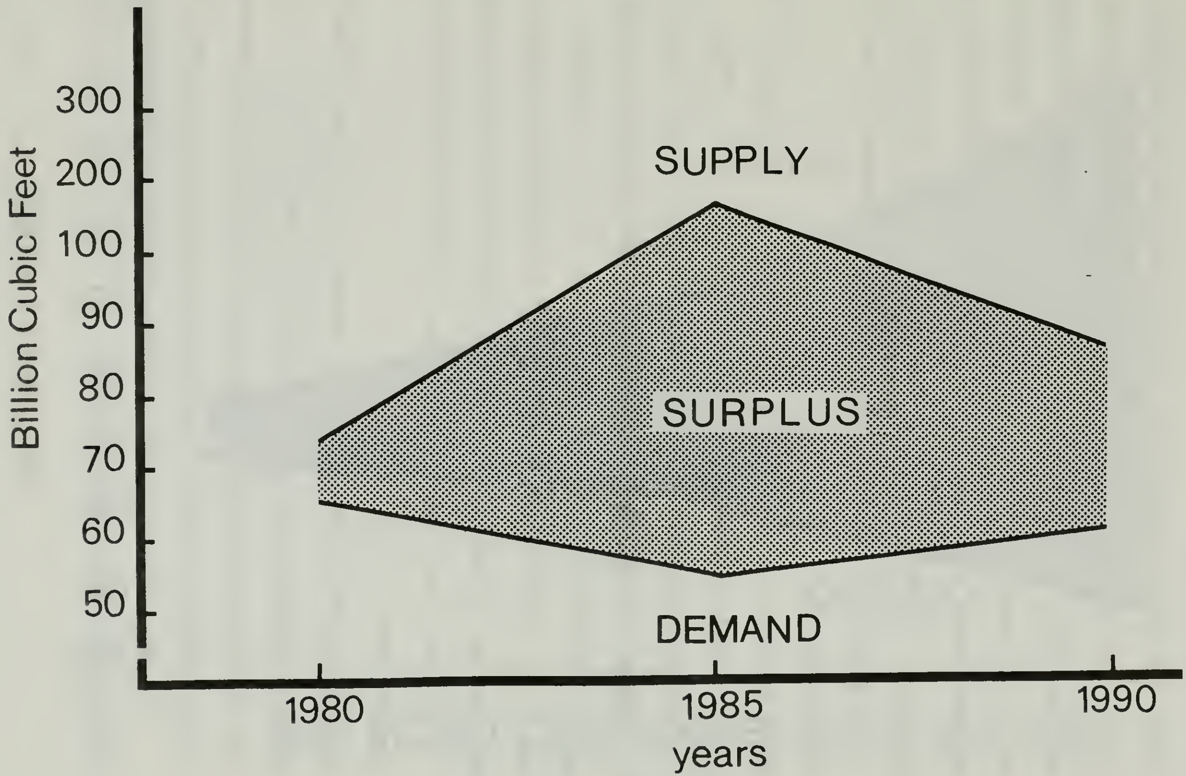


figure 10

IMPACT OF NATURAL GAS DEMAND ALTERNATIVES

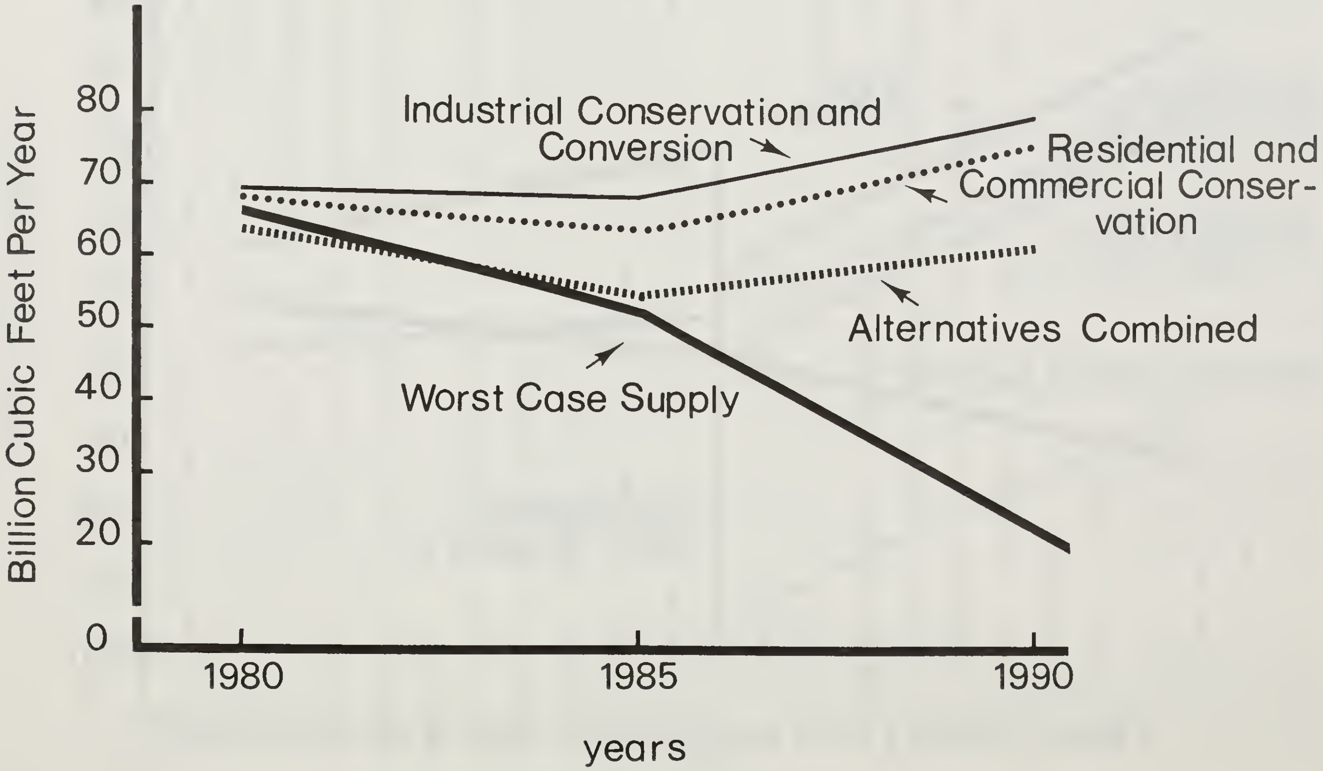
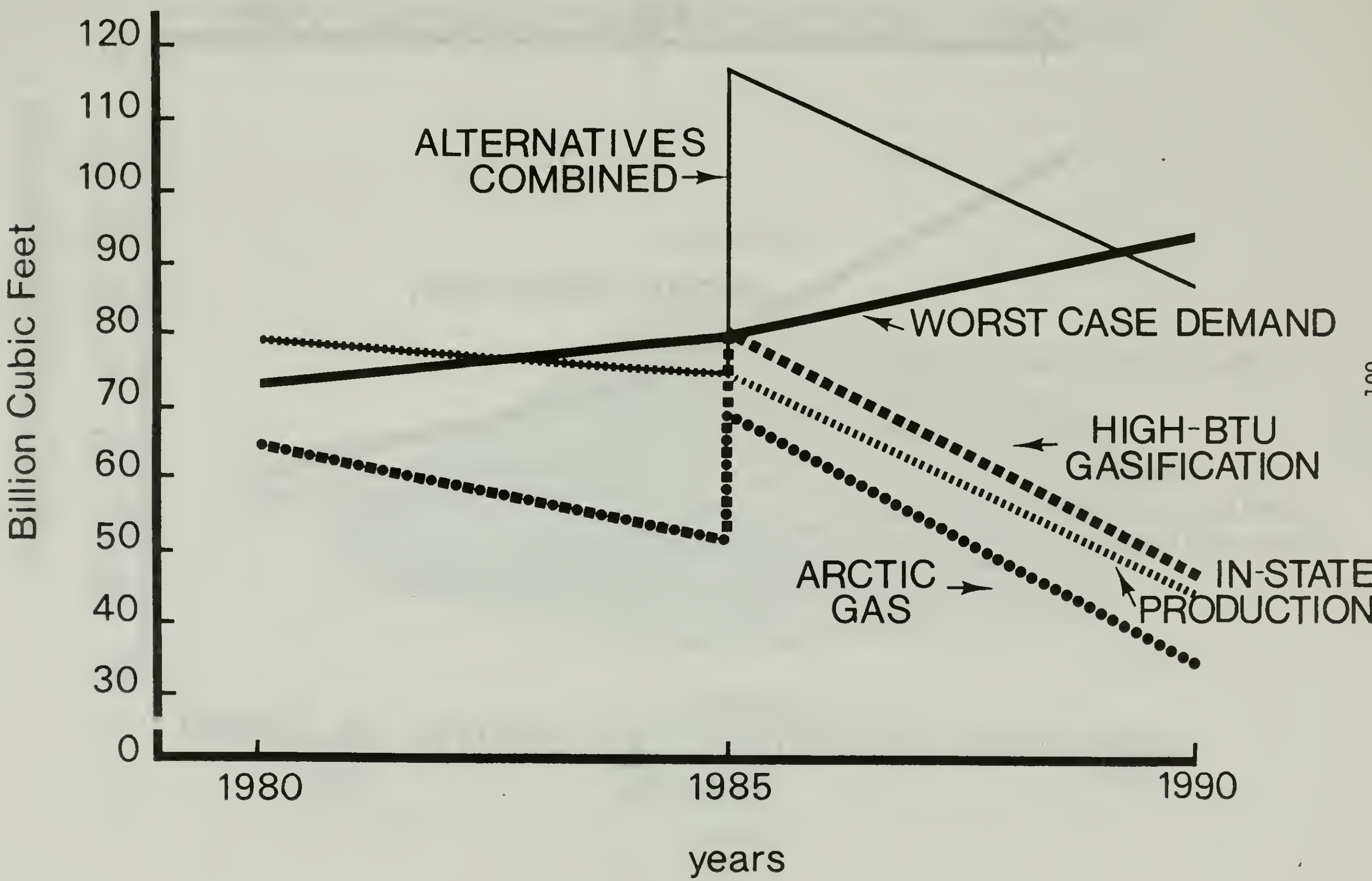


figure 11

IMPACT OF NATURAL GAS SUPPLY ALTERNATIVES



prevent the 1980, 1985, and 77 percent of the 1990 shortages (see Figure 12). The contribution to supply by increased in-state gas production assumes a price of approximately $2.00 per mcf (at the wellhead in 1976 constant dollars). This alternative produces a large surplus through 1987, which could be stored for use later. The remaining 23 percent of the projected 1990 shortage, if it occurred, could be met by allowing the price of gas to rise higher after 1980, use of additional alternatives, or storage of the surplus created by increased in-state production.

The least cost alternative would be the demand alternatives combined with increased in-state gas production for in-state use. This combination could meet the projected shortages through 1985. The least cost alternative could not meet all of the 1990 shortage, so at some time around 1985 other alternatives would have to be implemented. This set of alternatives is also the most certain of the alternatives available.

Figure 13 indicates that high-Btu gasification can also be combined with the demand alternatives to meet the 1980 and 1985 projected worst case shortages, assuming construction of a demonstration size plant. Such a combination would meet 80 percent of the 1990 projected shortage, with the remaining 20 percent to be achieved with the addition of other alternatives or the construction of an additional demonstration size or larger gasification plant.

When combined, the high-Btu gasification and demand alternative mix would provide more employment. However, the bulk of the new jobs will be limited to temporary construction employment at the plant site. In addition, the increase in employment would be obtained at an additional cost of approximately $1.00 per mcf ($3.00/mcf for synthetic gas minus $2.00/mcf for in-state gas), representing an additional cost to Montana consumers of $56 million dollars per year by 1990.

figure 12

IMPACT OF LEAST COST ALTERNATIVES ON WORST CASE PROJECTIONS

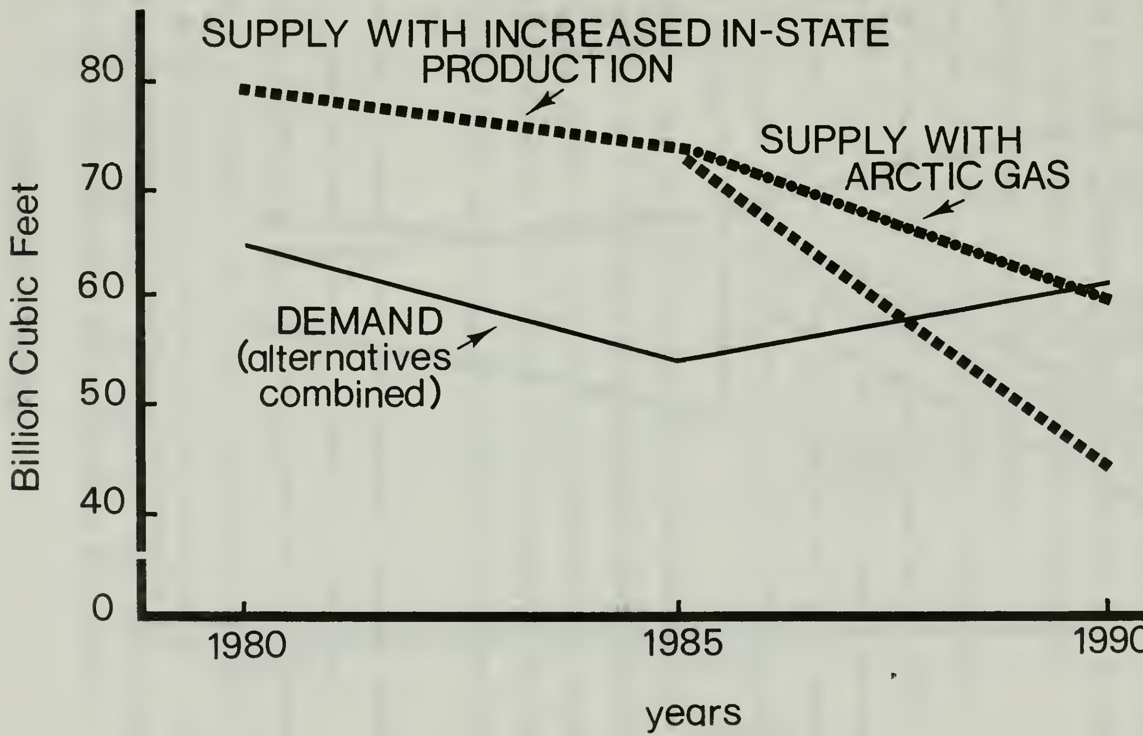
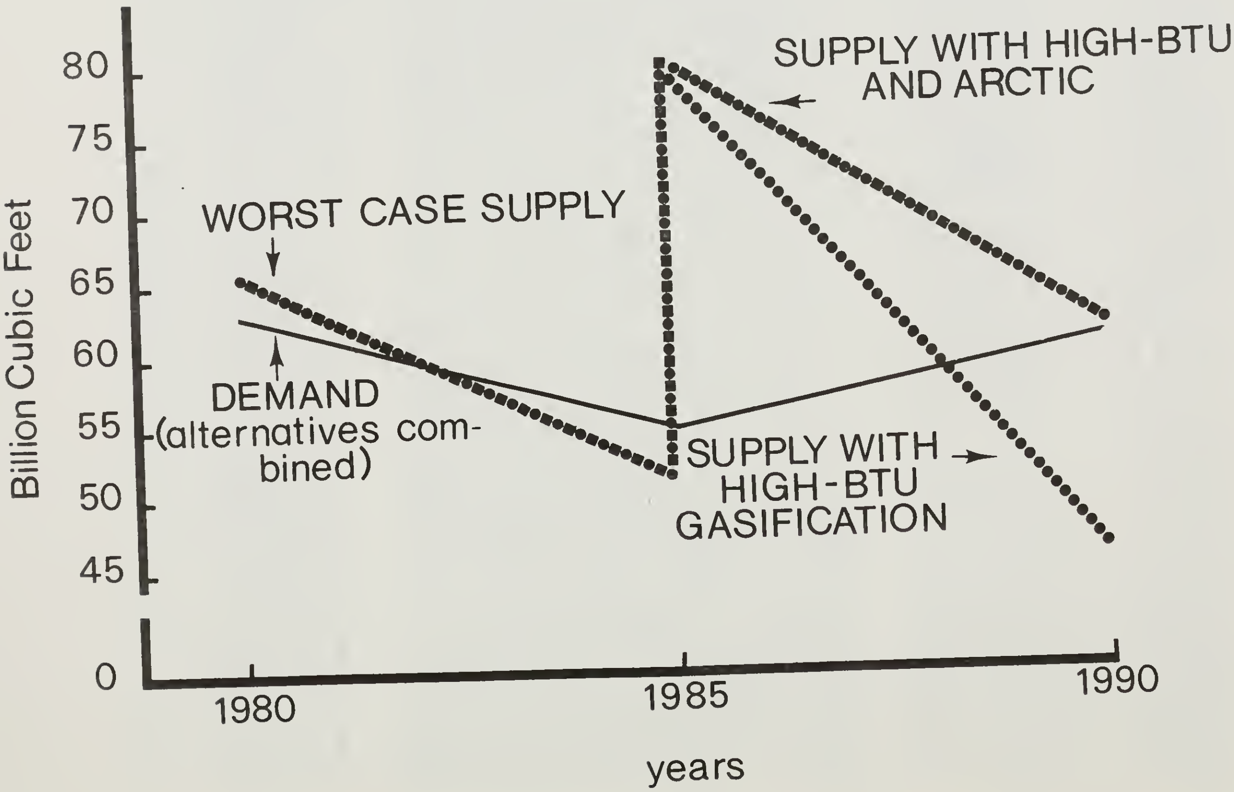


figure 13

IMPACT OF DEMAND ALTERNATIVES, HIGH-BTU GASIFICATION AND ARCTIC GAS ON WORST CASE PROJECTIONS



NOTES TO TABLES AND FIGURES

Table 1 shows the rate at which demand for natural gas increased or decreased (-) from 1960 to 1975. Growth in natural gas demand is adjusted for changes in population for that portion of the table identifying Per Capita Rates of Growth and contrasted with general energy demand patterns. Data compiled by Terry Wheeling of the Montana Energy Advisory Council staff and were based on material from the American Gas Association and the U.S. Census Bureau. Source: Reference 1.

Table 2 illustrates Percent of Natural Gas Used by Montana Residents for Various Appliances. The table shows to what purposes (end uses) and in what amounts the residential sector uses natural gas. The principal finding is that space heating accounts for the largest use of gas in this sector. The MEAC (Montana Energy Advisory Council) and EQC (Environmental Quality Council) estimates are both given to show results obtained independently using different approaches. The methodology for the MEAC estimate is as follows: 1. Multiply the total number of Montana housing units (217,300 based on the 1970 Census of Housing) times the percent of Montana households using the appliance (based on Montana Power Co. appliance saturation survey conducted in 1971). The product represents the total number of homes in Montana using that appliance. 2. Multiply that product by the national average (based on American Gas Association, Gas Facts, 1974). This represents the estimate of the amount of gas used for each appliance in Montana, which is shown in the column labeled Calculated Montana Consumption. 3. Determine the percent of total calculated Montana consumption which each appliance uses. The total natural gas demand which was able to be attributed to various residential end uses was 23 billion cubic feet. The total natural gas demand in the residential sector in 1970 was 23.5 billion cubic feet. Sources: References 1, 2, and 3.

Tables 3 and 4 illustrate that most of the natural gas used by Montana industrials can be substituted by other fuels. No Substitutes corresponds to the Federal Power Commission's Priority 2 classification. Unknown is Priority 3 and Substitutes is priorities 4 through 9. Data in Table 3 was supplied by Montana Power Co. to the Montana Public Service Commission in 1974. Data in Table 4 was supplied by Montana-Dakota Utilities to the Federal Power Commission in 1976. Sources: References 4, 5, and 8.

Table 5 shows the rates at which most Montanans buy natural gas. Very few residential consumers use over 25 mcf per month. In the Montana Power Co. service area the schedule is different for residential and commercial customers; in the Montana-Dakota Utilities service area, they are combined. Sources: References 11 and 12.

Table 6 identifies the amount of natural gas which western Montana industrial consumers are planning to save beyond their estimated growth in gas demand. This figure is reported as Total 1980 Savings. These industrial consumers have identified 6,684,852 mcf which they plan to replace by either conversion to alternative fuels or conservation. Equipment which will produce this savings is either on order, being installed, or in operation. It should be noted that this total savings is offset by an estimated growth in demand of 1,640,291 mcf by 1980. The Net Savings is 5,044,561 mcf. Sources: References 6 and 7.

Table 7 presents the EQC staff worst case shortage for western Montana, calculated according to the following methodology: Demand: A 1.5 percent annual increase in residential and commercial demand was assumed. For 1980, the planned industrial growth as well as the planned industrial conservation and conversion was assumed (see Table 6). For 1985, it was assumed that one-eighth of the remaining substitutable industrial natural gas demand would be converted. For 1990, it was assumed that an additional one-eighth of the remaining substitutable demand would take place. For the years 1985 and 1990, it was assumed that non-substitutable demand would grow two percent annually. (See Tables 3 and 4 for substitutable industrial natural gas and Table 6 for planned industrial conversation and conversion.) This portion of Table 7 compiled by the EQC staff. In-state Supply: For the 1980 figure, Montana Power Co. estimates were used. For 1985 and 1990, it was assumed that in-state contribution to supply would peak in 1980 and decline at the rate of one billion cubic feet per year thereafter. Source: Reference 16. Canadian Imports: The figures used in Table 7 are Montana Power Co.'s estimate of what future imports would be and were confirmed by outside energy experts. Sources: References 25, 26, 27, and 28.

Table 8 represents the amount of natural gas eastern Montana industrials are planning to save by 1980. Information was obtained through interviews with individual companies by the EQC staff. Sources: References 6 and 7.

Table 9 gives estimates of supply and demand in eastern Montana and are taken from Montana-Dakota Utilities application for curtailment of industrial service made before the Federal Power Commission. The worst case projections for eastern Montana include growth in residential and commercial natural gas demand. It does not assume any industrial curtailment and no conversion from gas is assumed beyond that planned to occur by 1980. Also, MDU's anticipated reserve additions of 30 billion cubic feet per year are not included here. Data compiled by the EQC staff from Reference 4.

Table 10 is a combination of Tables 7 and 9. See the references for those tables. Compiled by the EQC staff.

Table 11 indicates that a 40 percent reduction in 1975 natural gas demand is the reasonable maximum which could be achieved by increased thermal efficiency in residential and commercial buildings. The figures given in Table 11 are based on various percentage reductions from existing space and water heating demand, given in the Percent of Residential and Commercial Demand columns. The impact of the conservation program for existing residential and commercial demand is estimated by assuming that only part of the maximum will occur over time. The 1990 estimate of a 30 percent reduction means essentially that every existing home or commercial building will reduce gas demand by 30 percent (10 percent less than the reasonable maximum) or that 75 percent of the homes will reduce gas demand by 40 percent or a combination of the two. Sources: References 29 and 30.

Table 12 suggests that natural gas demand for new residential and commercial buildings can be reduced by 50 percent with energy conservation-oriented design and the use of more energy efficient space heaters, e.g., heat pumps. The shortage projections used in this report allow for 16 billion cubic feet of gas for these new buildings. Table 12 illustrates what the reduction would be with a vigorous conservation program oriented toward new construction. Compiled by the EQC staff, based on data contained in References 29 and 30.

Table 13 is a combination of Table 11 and Table 12. See the notes accompanying those tables. Compiled by the EQC staff.

Table 14 is a summary of information obtained through EQC staff interviews with individual companies in Montana. The companies interviewed represent over 80 percent of the existing industrial demand for natural gas in Montana. The Capital Costs data are estimates but are assumed to be accurate within 15 percent. The Amount of Gas Substituted column is also accurate within that range. Table 14 only includes reductions in natural gas demand not presently planned; that is, the equipment required to achieve the reduction has not been ordered.

Table 15 outlines a program which, if it were adopted, would yield the results contained in the table. The emphasis here is on providing incentives for industrial conversion and conservation of gas. The 1985 and 1990 Impact on Shortage Projections figures must be adjusted for the amount of conservation and conversion assumed to occur in the western Montana worst case shortage projections. These adjustments were calculated as follows: For 1985, the total conversion and conservation estimate of 11.3 billion cubic feet must be reduced by 0.811 billion cubic feet as is assumed in the worst case shortage projections. For 1990, the 15.98 billion cubic feet of conversion and conservation must be reduced by the 1.622 billion cubic feet assumed to occur in western Montana. The 1990 Total Effect is assumed to one-half of the remaining substitutable gas demand. The 1990 cost estimate is based on the same capital cost/gas saved ratio found

in the 1985 projections listed above. Compiled by the EQC staff, based on data contained in References 6 and 7.

Table 16 gives three estimates of Montana's undiscovered natural gas reserves. Undiscovered reserves are those undiscovered resources which are estimated to exist in an economically favorable geologic setting. The 95% Chance of Occurring estimates use the same methodology used by Dr. Ibrahim in his Undiscovered Natural Gas Resources of Montana. (See Reference 19.) The 50% Chance of Occurring estimates were made by Dr. Ibrahim in his study for MEAC. Both estimates are based on undiscovered reserve data of the U.S. Geological Survey, released on December 31, 1974. The "Steering Committee" was a group of geologists working in the gas industry in Montana who reviewed Dr. Ibrahim's report in July 1976. Since these steering committee estimates were based on new economic and geologic information obtained after the USGS survey, the estimates are higher. Years of Supply was calculated by dividing the total reserves by the 1974 level of natural gas consumption.

Table 17 calculates the Increase to Montana Supply by subtracting from Annual Production the level of production assumed to occur in the worst case shortage projections (see Tables 7 and 9). This figure should be multiplied by 60 percent (0.6) to determine the increase to Montana supply. These estimates provide for 40 percent of the available gas to be distributed to interstate sources. The $2.00 Wellhead Price per MCF is the level of contribution used in all projections of this alternative's impact. The levels of Annual Production were drawn from the EQC Natural Gas Producer's Questionnaire (see Reference 15).

Table 18 reports the history of estimated cost and completion dates for three high-Btu gasification projects. The information was compiled by the General Accounting Office, based on data supplied the Federal Power Commission by the individual companies. Source: Reference 42.

Tables 19 through 24 were compiled by the EQC staff based on data contained in the text of this report.

Figure 1 shows the amount of gas delivered to each major type of consumer in Montana. Based on data provided by the American Gas Association. Source: Reference 2.

Figure 2 shows the price paid for natural gas delivery over time. Based on data provided by the American Gas Association. Source: Reference 2.

Figure 3 is the same data presented in Figure 2, adjusted for the effects of inflation. The price figures given in Figure 2 were adjusted using the Consumer Price Index for all goods and services (1967=100). This adjustment shows the rise and fall of the price paid for gas in relation to the general trends in the economy. Data used here was compiled by Terry Wheeling, Montana Energy Advisory Council, based on data obtained from the U.S. Department of Commerce and the American Gas Association. Sources: References 1 and 2.

Figure 4 illustrates major sources of Montana's supply of natural gas. Based on data compiled by Terry Wheeling, Montana Energy Advisory Committee. Source: Reference 13.

Figure 5 shows the highest prices paid for old and new gas at the wellhead by Montana Power Co. since 1948. Based on data provided by Montana Power Co. Source: Reference 16.

Figure 6 records the highest price paid by Montana Power Co. for Canadian natural gas imports. The prices are given by year and by port-of-entry. Based on data supplied by Montana Power Co. Source: Reference 16.

Figure 7 compares the amount of money spent by Montana Power Co. for its natural gas exploration and development activities in Montana and Canada. Exploration and development funds spent by Montana Power Co. are for in-state activities; the money allocated to Canadian-Montana Gas Co. is spent in Canada. Based on information furnished by Montana Power Co. Reference: Source 16.

Figure 8 is a graphic representation of the data presented in Tables 7 and 9. It is the worst possible supply and demand situation Montana could face. Compiled by the EQC staff.

Figure 9 graphically illustrates the Montana supply and demand situation which would occur if all the alternatives discussed in this report were pursued. These figures were derived by subtracting from worst case demand (see Tables 7 and 9) the anticipated effects of residential and commercial conservation and industrial conversion and conservation. The supply figures were calculated by adding to worst case supply the effects of increased in-state production for in-state use, high-Btu gasification and Arctic gas. Compiled by the EQC staff.

Figure 10 represents the projected Montana gas supply and demand situation if only the demand alternatives discussed in this report were pursued. The lowest demand line was calculated by subtracting from worst case projections the effects of residential and commercial conservation and industrial conversion and conservation. The other two lines were projected by subtracting individually the effects of the two demand alternatives from worst case demand projections. The supply line represents the worst case supply projections presented in Figure 8. Compiled by the EQC staff.

Figure 11 presents the supply and demand situation in Montana if each and all of the supply alternatives were implemented. The supply lines were determined by subtracting from worst case supply projections the effect of each alternative and all alternatives combined. The large 1985 jump which occurs for some alternatives is due to the fact that they cannot make a pre-1985 contribution, so the supply line is that of the worst case supply projections. The rapid post-1985 decline in supply for all alternatives is due to the cutoff of Canadian imports. The demand line is worst case demand as identified in Figure 8. Compiled by the EQC staff.

Figure 12 shows the supply and demand situation if Montana pursued the demand alternatives and increased in-state production for in-state use (see Figure 10). The Arctic gas alternative is also added to in-state production after 1985. This additional contribution could be made by a combination of other alternatives or storage of gas supply surpluses. Compiled by the EQC staff.

Figure 13 shows the supply and demand situation if Montana pursued the demand alternatives in combination with high-Btu gasification (see Figures 10 and 11). The pre-1985 supply line is that of the worst case supply projections as the high-Btu gasification plant would not be operating until 1985. This contribution to supply also accounts for the jump in the supply line in 1985. Compiled by the EQC staff.

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